

AMERICAN  
RAILROAD JOURNAL,  
AND  
MECHANICS' MAGAZINE.

Published Monthly at 23 Chambers-st. New York, {  
at \$2 a-year, in advance, or 3 copies for \$5.

{ By GEO. C. SCHAEFFER, and  
D. K. MINOR, Editors.

No. 2, Vol. 2. {  
Third Series.

FEBRUARY, 1844.

{ Whole No. 433.  
Vol. XVII.

For the American Railroad Journal and Mechanics' Magazine.

REMARKS ON MR. ELLET'S FORMULA—COST OF TRANSPORTATION ON RAILWAYS.

In the December number of your Journal, my remarks on this formula of Mr. Ellet's, were perhaps sufficient to show that it was not possible to construct one, which could be of any practical use for determining the present value of any specific railway, and still less of one in contemplation, the constant tendency towards amelioration in all the departments of this improvement, rendering the data of to-day no longer applicable on the morrow. It was there also shown, that in the very nature of the railway, the condition is implied that it must always be kept up in full repair, the neglect of this condition leading to its abandonment by the public, and the consequent ruin of the concern. Hence like old wine, a railway should be and generally is, all the better for its age, and it may be broadly asserted, as the *result of this condition*, that there is not one of our earliest railways of any note, which is not now better than it ever was, and is, moreover, daily growing better in some one or other of its details. Even in the case of the *Columbia*, a Pennsylvania *State road*, this is strongly exemplified, the daily expense of management being reduced to \$350 per day in 1843, as compared with \$760 per day in 1839 and 1840, the result as well of improvements as of better economy. Every railway must thus stand on *its own merits*, no two being found sufficiently under a parity of circumstances to admit of the one being any rule for the other, this being long since received as an *axiom* with all intelligent railway engineers.

I shall now continue my remarks upon the further article which appeared in your December number, from Mr. Ellet, in support of his formula.

In the first place he gives another table of the repairs and expenses of engines and cars for several roads, which is good, so far as it shows a variance in this item of from five to ten cents per mile run, or of 100 per cent.; but of what use is an average for *particular application* from such extremes as this?

In the next place he gives another table of the repairs and expenses of cars and engines for several roads returned in one item; on which he pro-

perly remarks, "it is the custom of many companies to publish the cost of repairs of their engines and cars in a specific item, so as to make it impossible for the reader to determine from their accounts what portion of the bill was created by the engines, or the difference between the repairs due to different sorts of cars." Nothing daunted by this incongruous mixture, he proceeds with his deductions, and to fix laws for these expenses, giving and taking as it suits his purpose, and reduced also occasionally to the hard necessity of being obliged to suppose.

A seeming approach, now and then, to some agreement between the *actual* expenses and the *calculated* ones, by his formula, has naturally the effect of misleading him, when it is only the result of accident, and comes from the roads compared by him being nearly all alike in the *small ratio* which the actual business done by their establishments and machinery, bears to the *much greater* amount they would be equal to, did the business exist for them. This feature is strongly marked on all his tables, and is at first inseparable from a railway, which in itself and its equipment must be a good deal ahead of the business existing for it at the outset, but as experience shows that under the influence of a railway, this business has a constant tendency to expansion, while at the same time all the parts of the machine, getting to be worked more in unison and towards the one single purpose of economy, its earnings increase, and the proportion of its expenditures diminish. This has been signally manifested in the case of the Columbia road just adverted to, as well as in that of perhaps the earliest pioneer in this improvement with steam power, the Baltimore and Ohio railway, which, after narrowly escaping the trials of infancy, has been of late years gradually approaching towards a *fullness of business*, and of this even Mr. Ellet could not help being struck, when he remarks, that the *actual* cost for the road falls considerably below the *computed* cost for 1843, but without perceiving, or being willing to acknowledge, that it was owing to this expansive tendency; another remarkable instance of which I find in the Georgia railroad report for 1843, in which it is stated, that with an increase of only 353 miles run by the engines, it delivered in that year 23,000 bales of cotton more than in 1842. At this rate Mr. Ellet's formula would be kept for ever at fault. In England, in the midst of its dense population and business, few railways suffered long in a disproportion of their establishments, and the work for them to do; but here, in this country, where these essential elements of success are sparse and small, much disappointment had to be suffered and patience borne, before in most cases, that evil could be overcome. This expansive principle is ever active on railways, and, under *low charges*, being more particularly influenced by it than any of its rivals, its chances of survival and of ultimate triumph are generally the best in cases where it may have to contend against strong and unusual competition, and the business is not more than enough for one. No better evidence can be adduced of any extended confidence with the public in this improvement, than the rise in the stock of most railways, the Reading included, in the last few months, some of them bearing the high-

est premiums of any on the stock list. While on this part of the subject, we cannot do better than quote what is said of it in England, where the interest being large, it is likely to be best understood, and where the most unbounded reliance on its permanent safety as a profitable investment is being constantly manifested, which could not be, either there or here, if Mr. Ellet's theory were true.

"Other things being alike, if the receipts are higher, the percentage of expense will be less—and vice versa; again, the more business, the less in proportion is the expense at which it can be done, simply because the standing expenses will bear a less proportion to the receipts when great than when little. In determining the comparative value, or the per centage of profit on different lines of railway, the first consideration is to look at their respective amounts of capital, as the smaller this may be, the more likely is it to pay well. This is affected by many circumstances, not always controllable, but in respect to which it is now only of use to remark, that after a vast amount of dear bought experience, the first outlay can now generally be kept down to a saving of one-third of the old limits, and for a very superior article. Between recently built railways, and still more so with those which may be contemplated, and their pioneer progenitors, comparisons in first cost and in useful and profitable effect will no longer hold, where they connect equally suitable points."

Thus for England at least the railway system is considered not only permanently safe, but can be relied upon as continuing to maintain a progressive career. Here, however, this encouraging view is not so general, and the counter interest of canals, is forever busy in repressing it—and not satisfied with endeavoring to make it the most self-devouring machine by its ordinary expenses. Mr. Ellet thinks he has brought against it a "wear of iron," which alone would be beyond compensation by any probable amount of business, and under which the whole system must inevitably break down. But on this main item of the *wear of the rail* let me quote his own words, that he may not be misunderstood.

As a sort of summary of his views on this head, he remarks:

1st. "That great errors have been committed in the consideration of this subject, in overlooking the fact, that the progress of the wear is rarely ascertained, or in the least appreciated, until the rail is destroyed. The annual charge for iron is very small, because in general the track does not appear to give way until it is nearly unfit for use. When repairs really commence, the destruction is so far advanced that the iron must be renewed, and if the directors assert, as they usually do, in their next report to the stockholders, that experience has shown that the original iron is very bad, and has all been crushed, the explanation is satisfactory, and the cost of the new iron is forthwith charged to the account of construction."

In order to show the estimate of loss he has arrived at on a particular form of rail, and after distinctly stating that he considers the so called improved edge rails as *more perishable*, he remarks,

2d. "That the common half-inch flat bar, under ordinary circumstances, is adequate to the transportation of 150,000 tons of freight. Such bar on the Petersburg road, where the freight amounts to some 25,000 tons, would resist the wear of some six years' business; but if the trade of one year of the Schuylkill canal (say 7 to 800,000 tons) were poured along it, the iron part of the track would need entire renewal six times in one year."

But few of our readers can fail to be struck with the novelty of the idea in the first quotation, that the destruction of a rail thus steals upon one like a thief in the night, and not being in the least appreciated, until the *whole track* breaks down at once; and still more novel will it seem to them, that the cost of renewal is all supplied forthwith in a lump, by merely *asking* for it. This is a readiness of means, which few, if any, of our railways ever suspected themselves of possessing, under ordinary circumstances; and under

such effects as Mr. Ellet attributes to a Schuylkill *fresheret of tonnage*, not one of them would hope to escape, in the *money line*, *utter extinguishment*.

In my own justification, however, I should state, that I doubted much whether these quotations should be treated seriously, as carrying in them their own refutation; but as the public in general look but seldom into this subject, or have the means of much correct information in respect to it, I have thought it as well to show that it is only by an entire ignorance or perversion, through misunderstanding I hope, of the facts in the case, that Mr. Ellet has been able to concoct such results.

Everybody knows more or less of the origin of steam railways for the purpose of quicker travel and transportation. Not knowing better, they commenced with a light plate rail, but soon found out, that the stringer or *continuous support* it required, could not be kept continuous, but was forever decaying and leaving the rail unequally, by which it was sooner or later bent into ridges, according to the weight of the then more destructive locomotive. This soon induced the use of a thicker flat bar, and so on from the plate rail of 15 pounds, the weight has been gradually increased to 80 pounds per yard, disposed of in various shapes to produce the greatest possible strength, principally to meet a continued increase, until lately in this country, of weight of locomotive, the best form of rail for this purpose being yet an open question, and in which further improvements will continue to be made as suggested by experience. It is in the course of these transitions during the last fifteen years, from light to heavier rails, in search in fact of the *adequate*—and towards which, in England, the Liverpool and Manchester, as the pioneer, contributed so liberally—that Mr. Ellet has thought to find his cases of destruction, and to assume upon these mere replacements of a heavier for a lighter rail, that a serious *dead loss* was incurred, when in fact the old and *merely defaced* iron often, in the case particularly of the flat rail, always realized first cost, and sometimes a profit; that on the Mine Hill road having, as one instance, sold at \$70 per ton. Here, then, is found the true version of the several cases of rails destroyed, as adduced by Mr. Ellet, and that this is so, as well as that there may exist not even a *shadow* of ground for the very perishable character he attributes to it, but on the contrary, that it has abundantly proved itself to possess a suitable durability, I subjoin a list of roads on which the rails were laid *some time prior* to those cited by Mr. Ellet as long since destroyed, which are *still in use*, and likely to remain so until the concerns can afford to change them, or for an indefinite period. The following are those, among several others, that I will refer to, as having still down their original iron, either in whole or in part:

	Flat rail	In use for 10 years,	Steam power.
The Mohawk and Hudson,	do.	(40 miles of old track) 12 "	
The Baltimore and Ohio,	do.	"	
The Harlem railroad,	do.	11 "	Horse and steam power.
The Utica and Schenectady,	do.	7 "	Steam power.
The Columbia road,	Edge rail	3 "	

All these roads have had their iron put to the severest test, the Harlem in particular, over the city part of the track, some 300,000 tons in human flesh and cars passing annually, and which must by this time have borne over one

million of tons. The other roads have all been battered by the heaviest locomotives, and made to suffer especially on their curves, from which few are exempt, and although made no account of by Mr. Ellet, are the most fruitful source of wear and tear to both road and machinery, particularly on the Columbia railroad. But as establishing the fact of the little injury sustained by the flat rail from the rolling of mere tonnage over it, we find by reference to their reports that there have passed up to this time over the

Mauch Chunk Lehigh railroad in coal descending and ascending cars a tonnage of	3,160,000 tons
Lackawanna " " "	2,600,000 "
Mine Hill " " "	1,600,000 "

Now as the rail could save nothing by *rest*, the wear would be the same had the above tonnage passed over it in *a month*, or in a *series of years*, and therefore for Mr. Ellet to assert that such a mere *bagatelle*, comparatively, as 150,000 tons, would destroy the Petersburg rail in six years, and that the tonnage of the Schuylkill for one year, about one-fourth of that already passed over the Mauch Chunk road, would require it to be renewed *six times* in one year, is utterly preposterous. Neither do the parties concerned in the above roads entertain a doubt of the iron on them continuing to be useful for many years to come, all of them showing annually an increased transportation. But what is most singular, is to find Mr. Ellet maintaining that all the world have been asleep in this matter of the sudden breaking down of the iron on railways, and that as it were, it has been left to him to give the first alarm and wake them up. It would indeed be marvellous, if at this late day, no notice had been taken of this very important fact, or that it would not indeed have proclaimed itself and have arrested the further prosecution of the railway, particularly in England, where the iron is treated without mercy; as regards weight of locomotive, length of train and above all in the highest speeds—30 miles for travel, and 15 miles per hour for freight. What took so many of the Continental engineers to England, and afterwards brought them here, but to learn how it stood in particular, in respect to this *vital part* of the system. And does not the spread since of railways over all the Continent, establish the fact, that the cost for renewal from wear of the rail, as I stated in my former remarks, was ascertained by them to be compassable by a *moderate* annual charge after allowing for old material, generally worth two-thirds of the new; and this *without limit* to the trade to be passed over it? This being most particularly important to the Continent, where iron is generally expensive, pains were in consequence taken to be sure of the fact. The latest reference we can find to the subject in England, where it is now no longer matter of concern, is in a lecture of Professor Vignoles, and he there says:

"That the result of a variety of experiments on the malleable iron rails of the Stockton and Darlington colliery railway gives one-tenth of a pound per yard per annum, as the absolute amount of fair abrasion. Some statements, however, made it much higher, being one-sixth of a pound per yard. On the Killingworth colliery it was one-eighth of a pound. On the Liverpool and Manchester some years ago, the wear was found constant at about one-tenth of a pound per yard per annum. At this rate it would take 100 years to wear away a rail from mere abrasion; but later experience shows that the increased weight of the locomotive acts very destructively on rails whose upper webs are not sufficiently strong."

and of the best manufacture. We may take ten tons as the present average weight on one pair of driving wheels of English locomotives."

The colliery railways here alluded to by him pass annually 700,000 to 800,000 tons by steam power, and confirm the experience here that from mere abrasion the loss to the rail is the merest trifle, and which is only of any moment, when in the case of *inferior iron* it is liable to be partially torn and exfoliated by the slipping, principally on the *curves*, of heavy locomotives. A good deal of bad iron of both flat and edge rails was at first imposed on railways, both here and in England, forming the exception and not the rule in the case. This arose partly in the attempt of the English to make as cheap rails as the Welsh manufacturers, without having as good mineral, and leaving out some of the refining processes, and this was not at first so much cared for, until the hammering of the locomotive taught them that the top tables of the rails at least could hardly be too good and malleable, and to these the proper degree of toughness is now given. In England the iron on railways is like the wood in this country, cheap and not so much an object, and hence they could be liberal in the weight of rail, rather than seek to diminish that of the locomotive, which would there involve a loss of power they could not afford. But here our interest has been to economise iron in the rail, and to this end all the mechanical ingenuity in this line has been turned, until the desideratum has been at last attained of making *all the weight* of the engine *useful*, at the same time, so distributed that with treble the power of the old style of machine, it presses but little more on the rail than an ordinary car—that is, the pressure from any *single* driver need not exceed two tons, while in England it is four to five tons, with only half the efficiency. The economy of this improvement must pervade the whole system, and may be said to make a new era in it, at which Mr. Ellet's formula, based on old or obsolete data, must cease to be applicable, if at any time it were good for anything. The thanks of all the lighter roads and with unfavorable grades, and indeed of all sorts of railways are fully due to Messrs. Baldwin and Whitney for this their latest ingenious effort; and many have already given more substantial proofs of acknowledgment, by the adoption of this admirable engine, and all of them, after several months trial, testifying to their unequivocal superiority. It will be at once perceived how great may be the saving of iron on a road using these locomotives, with which 50 pounds to the yard would be our maximum.

I would here notice the very crude notions entertained commonly as to the relative cost of transportation on a railway of passengers, merchandize, minerals and other heavy products, the impression being that *travel* is that which costs least, when, according to Professor Vignoles, whose experience is not small, he states it to be *twelve* times dearer than *minerals*, and *six* times dearer than merchandize, carrying weight for weight, or reducing them all to tons. This, in the case of minerals, as coal, arises in its being the only species of transportation which *always* affords *full loads*, and the saving generally in the comparatively *low speed* at which it is carried; and

this explains why the *colliery* railways in England *pay best*, notwithstanding the very low rates at which they carry, even with indifferent gradients and for their weights, comparatively inefficient engines for so doing. Some there are, who, when its carriage is associated with a railway, entertain the school day notion, that a ton of *coal*, in particular, is *heavier* than a ton of *feathers*, when in fact the latter, not any lighter of course, is the more *cumbrous* to carry, as may well be imagined of a train of 800 to 1000 bales of cotton, now a common sight on our light southern roads, since the introduction of the locomotive just alluded to, and equal to 320 tons gross load, over 30 and 37 feet grades, at a speed of 10 miles per hour, the engine weighing about 12 tons on 6 drivers.

It would appear, however, that the great aim of Mr. Ellet, in all this statistical diligence and research, is to prove the certain failure of the Reading railway, in its present attempt to wrest the coal trade from the Schuylkill canal, to which it runs parallel, between Philadelphia and Pottsville. If railways could be kept in a state of *infancy*, and confined to mere travel and a *small amount* of freight, Mr. Ellet's attention might not perhaps have been aroused; but this is not so, and as he expresses it—"Railways are now constructed to take the place of important canals, and to furnish the means of transport for the *heavy products* of the earth at *exceeding low rates*." As the consequence of this attempt of the Reading railway, Mr. Ellet asserts,

1st. "That it will not withstand the rolling of the trade of the Schuylkill (7 to 800,000 tons) for one year.

2d. "That it will cost from 50 to 75 cents to replace the iron which is destroyed by each ton of coal that descends from Pottsville to Richmond on the present track."

As to the first assertion, the testimony already adduced by me, proves the flat bar rail to possess sufficient durability, and might suffice for all other forms, but as the rail on the Reading road is of the edge pattern, and pronounced by Mr. Ellet to be the *feeblest* of the two, it will be useful to show that this, like all else that he asserts of the railway, is marked by the same inverted and therefore perverted, view of the subject, which misleads him and all kindred reasoners, while the improvement is *flourishing* all around them, into the mistaken belief that its days are nigh being numbered. It happens, unfortunately for him, however, that this very Reading railroad already furnishes itself the test of a competency far beyond what Mr. Ellet would allot to it, and comes very apropos to the overthrow of his kind prediction of its early fate.

Thus the *records* show that from its opening at the end of 1838, to the end of 1843, there has passed already over it a *nett tonnage* of 500,000  
Besides which there has passed, in descending and ascending cars, and in locomotive weight, a further tonnage in these five years, of *at least* 500,000  
Total, 1,000,000

making a gross tonnage of at least one million which has rolled over this Reading road in the past five years, thus affording in itself proof positive

that it can *more than* survive one year's business of the Schuylkill canal, its rail being still as good as new.

As to the second assertion, it is only of use, after this, to notice it with the view of holding up the enormities, of which Mr. Ellet is capable, towards a railway. Thus at 75 cents per ton on 800,000 tons, the wear would be equal to \$600,000, and at \$55 per ton to near 11,000 tons of iron *consumed per annum*; while the *whole track* does not contain much over 7,500 tons. At this rate it would not be possible to supply a new track as fast as the old was destroyed, not even were *saw and rolling mills* to be provided alternately with the water stations on its whole line. But with the help of my present expose, I may fairly trust it to the common sense of the reader to see that no such condition of things could ever happen.

Let me, however, look a little more particularly into this matter of the wear of the rail, and by reverting to the data given by Mr. Vignoles, assist the reader to understand it. The Stockton and Darlington does a large coal business of 700,000 to 800,000 tons per annum, besides 10 to 12 passenger trains daily, and the Liverpool and Manchester does also an immense business. The wear on both these roads is stated by him to be about one-tenth of a pound per yard per annum; each yard weighing say 60 pounds; the wear would then amount on a double track of 4 rails to four-tenths of a pound per yard, equal to 704 pounds of iron per mile, or for 94 miles 66,176 pounds; say 30 tons annually, and at \$55 per ton, makes only \$1,650 per annum, for the cost, on this data, from *mere abrasion* of rails. There will always be defective rails on a long line of railway, which will display themselves at intervals for several years, by exfoliation, until they are all expelled, and which may be estimated as about equal in cost to the abrasion. The road once freed from these imperfect rails, but little trouble is afterwards experienced; and the whole expense for renewals, less value of the crushed material, worth say two-thirds of the new will not then much exceed, say \$30 to \$35 per mile of road per annum; which will cover a very long period before the whole first cost of the iron is thus expended; and in the mean time this will no doubt be rendered the easier by the rails being, ere long, produced in the Schuylkill valley, on the very line of the road itself, the expense being then only the cost of re-rolling the rail and a small loss of weight—making it at least as cheap as they have ever been imported free of duty.

The fragility of the rail, therefore, is but a poor dependance on which to rely for getting rid of the competition of a railway, and so far from this being likely to be diminished hereafter, in the case of the Reading railway, its proprietors have lately determined on completing forthwith the double track with a 60 pound rail, and otherwise in wharves and additional cars, increasing its facilities for accommodating the coal business in particular, for which it was mainly constructed. The canal proprietors on the Schuylkill and the Lehigh are also said to be preparing themselves for the most determined resistance, so that coal, already reduced by this contest from six to three dol-

lars per ton, is not likely to rise soon, if it do not fall to a still lower mark. The dividends of the railway may in consequence be somewhat impaired for the moment, by this and other competition, but it will *always* be there as the *main regulator* of the coal trade, and until this is *acknowledged*, no permanent and just standard of charge, either by railway or canal, can be arrived at, by which all may at least, more or less, live and prosper. This is irresistible so long as in the plan of the present *lateral car and boat* required on the canal, the railway *supplies a car* as a substitute for the two first, and carries the same to a cheaper and more convenient point of delivery than is done by the boat. The continuance of low prices for coal in the next five years, must have the good effect of at least doubling the present annual consumption, estimated to be 1,200,000 tons of anthracite alone.

From some cause, Mr. Ellet would seem to have bound himself to *force a conclusion* that railways are yet of very limited capacity, and particularly unfit for the profitable carriage of *heavy* freight, as well because they would soon break down under it, as that they cannot afford to carry it as cheaply as its *small value* generally requires, which faculty, he would persuade us, and for hardly a better reason, however, than *old custom*, belongs only to canals; and with a Chinese reverence in this respect, opposes through thick and thin all innovation upon it. There was a time when this position had some slight color of support, but the ruthless progress of the age has overturned it, and now in the generality of cases, in this country particularly, it may be safely assumed that hereafter the railway will have the preference over the canal, even though its main object be that of *heavy* freight, in the *sound* of which, as before explained, there is far more terror than in its carriage. In the instance of the Reading railway, now so noxious in certain quarters, there is a peculiar adaptedness to this *heavy* business, there being here a union of steam power and gravity, with an unbroken connection in its terminations for the coal business, and what must give it an easy triumph over its rivals, the canals, in so far as becoming ultimately the **GREAT REGULATOR** of this trade.

If I have now *railed* too long at Mr. Ellet, I must plead in excuse the nature of the subject, and the very great importance of having it rightly understood by the public. Even in the great State of New York, against the experience around about them, this exploded doctrine of the cheaper character of canals is maintained—or pretended to be so—taking care, however, to *fetter* the railways which run parallel to their great Erie canal; this was a great project in its day, but its enlargement afterwards could only be effected by a constant and diligent circulation of the same erroneous views in respect to railways, which at this late day I find Mr. Ellet so zealous to keep alive. Ten millions have already been wasted in this enlargement, and fifteen millions of dollars more would be required to complete it, for which there are yet advocates, while two-thirds of this last sum would suffice not only to prepare the line of railways between Buffalo and Albany to do the whole business of the canal, but would suffice to carry the line down to

Goshen, and from thence, by railways already made, connect Buffalo and New York. The opponents of a railway to Albany always refer to the competition of the steamboats on the Hudson, as insurmountable. Now by steamboat the *through* traveller can only be delivered either way between Albany and New York *at a loss of the whole day and part of the next, besides the expenses of laying over*, which may all be estimated at \$1 50 to each ordinary traveller, and more to a business one; therefore, if the steamboat carried for *nothing*, this extra expense must be entailed, and would amply pay the railway in summer, and in winter it could have no opposition, being always able to make the trip between these great central business points in five or six hours. On the Erie canal there is now annually taken in tolls *two*—in freight *two and a half*—and in passage money *one million* of dollars, or in all about *five and a half* millions of dollars, between Buffalo and Albany, a distance of 363 miles. Now were the railways on this line allowed so to adjust themselves, as to do this large business, I believe they could do it all, at a good profit, for three millions of dollars, or effecting a saving of the present entire freight, of *two and a half* millions of dollars, with greater accommodation to the immense business on the line of the canal and railroads themselves, by not restricting it to a part of the year only. Any reform of this sort, may do to speculate upon, with little hope now of its being ever effected, the contrary interests having too strong a hold, besides an impenetrable ignorance of the comparative merits of these improvements generally, which cannot be suddenly dispelled. Both these obstacles, in the community which it most benefits, have done their worst to frustrate the Reading railway, but it has now attained a safe position, and at an outlay of say eight millions of dollars, will, in its way, represent the most formidable engine of transportation in the *world*. A vast dependant population, on the anthracite coal fields of Pennsylvania, should be ever grateful to it, for having freed them entirely from the monopolizing gripe of the canals, and with the all pervading economy of which the railway system is the source, to the *poor man* in particular, we should all be eager to lend it a pushing hand, rather than imitate Mr. Ellet in underrating its capacity and its usefulness.

F.

---

For the American Railroad Journal and Mechanics' Magazine.

NOTES ON PRACTICAL ENGINEERING.—NO. 5.

#### *Bridges.*

The suspension bridge of wire across the Schuylkill, at Philadelphia, Mr. C. Ellet, Jr., engineer, offers an admirable illustration of a position assumed in the last number: that the employment of engineers of education and experience to project a structure suitable to the locality, and adapted to its objects, would be attended with vast benefit to all interested; the community as well as the proprietors. The patentee of some particular mode of construction recommends his plan in all situations, and, to take the most favorable view of the case, let us suppose a bridge on Howe's plan, the best

patented American bridge, to occupy the place of the suspension bridge at Fairmount. It is unnecessary to draw any comparisons—the statement of the case is more than sufficient.

The cost of the wire bridge is said to have been under \$60,000: less than half the cost of the wooden bridge, which was burnt down; but, never having seen any other than newspaper reports, I am unable to offer any remarks on the subject, beyond stating that a saving in first cost and subsequent annual expenses will generally result from the employment of competent men. Besides this, I hold that neatness of appearance, and some little degree of harmony with surrounding objects, should not be neglected: indeed, I believe that these will—in the generality of cases—follow, to some extent, a judiciously projected bridge, without in any way increasing the cost.

Every traveller must have noticed the deplorable structures on which he often enters a beautiful village, and which, not unfrequently, disfigures its most populous thoroughfares. Here is an immense amount of employment which the profession should secure to itself, and which in other countries forms no small part of the business of the engineer. In this country, however, where bridges are more required than in any other, and where limited means strongly indicate the propriety of ascertaining the capability and cost of different plans, all is left to chance, and in place of adorning, the bridge is only too often the only drawback on the scene. For example, the lattice bridge across the Hudson, at the city of Troy, is in many positions of the spectator a complete "blur," in a view otherwise rather interesting. Numerous instances will suggest themselves to the reader, and I will only observe, that any engineer who will take the trouble to study any particular site for a bridge—be the span only 40 or 50 feet—will almost invariably strike out some particular plan, which, in his opinion, is superior to all the others he has considered; taking into consideration the nature of the traffic, the amount appropriated, the quality of the timber and stone and the surrounding scenery. Without exactly regarding this as the best possible plan, it will, in nine cases out of ten, be superior to the off-hand suggestions of an engineer of far greater pretensions.

The numerous bridges on the enlarged portion of the Erie canal offered numerous opportunities for improvement in these structures, and the experience acquired on that work had abundantly demonstrated the want of more efficient and lasting bridges. It is impossible to conceive anything more incongruous than the new bridges generally. The abutments are beautifully constructed of cut lime-stone, and are surmounted by a lattice bridge boarded and shingled. The abutments are not only permanent but costly, conveying no idea of limited means or even economy; the bridge itself is unsightly, perishable and combustible, and together they form a capital specimen of the "shabby-genteel" in engineering. Taking the cost of abutments and superstructure together, we should have had a sum sufficient to have adorned the route of the canal with a great variety of bridges, superior to the present structures in durability, economy of repairs and appearance, if in the hands

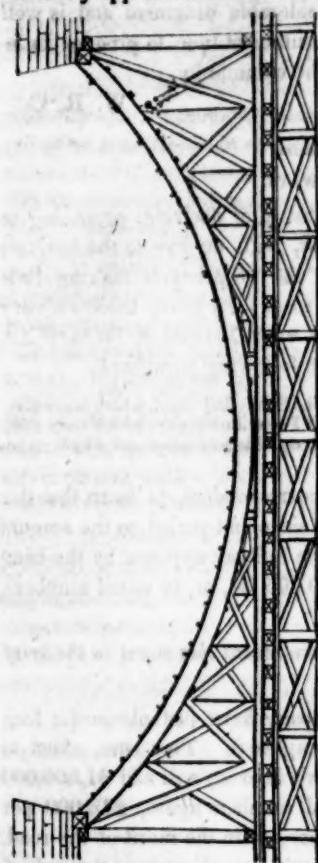
of competent persons; the Schuylkill bridge, already referred to, will sufficiently explain my meaning. With the exception of the bridge at Utica, designed by Mr. Whipple, engineer, I do not know of any attempt to introduce a bridge substantially new or differing from those in ordinary use.

Mr. Whipple's bridge consists of a flat cast iron polygonal arch, from which the roadway is suspended by vertical wrought iron rods, stiffened vertically by similar rods crossing each other and acting as struts as well as ties from their shortness. The strings or tie-beams are replaced by iron rods, so that the floor beams and the plank are the only perishable parts. The details are very neatly arranged, the bridge is remarkably stiff and may be easily rendered, practically speaking, fire-proof. Still the effect is not what it might be. A circular or elliptical arch would have looked better, and being of cast iron, a reasonable degree of ornament would not have added to the cost. But this might have prevented its adoption "in toto" by the canal commissioners, who, reckless of expenditure, have a most democratic dread of any design which can, from any cause—even simple beauty of proportion—give pleasure to, or elevate the feelings of, the beholder. This principle has been carried out to some extent on the Croton water-works. For example, the great arch at Sing Sing, built of granite in the best manner and at great cost, shows how much may be done towards reducing the architectural effect of a structure where the magnitude of the span, the nature of the material and the surrounding scenery conspire to produce a work which should do honor to the nation and to the profession, a praise which all must accord to the "distributing reservoir," though built mainly of rubble masonry, and of the simplest form.

The distinguishing characteristic of English bridges is that the timbers are all, or nearly all, subjected to compression; American bridges depending generally on a string or tie-beam. Now, where it is difficult to keep the grade high enough to clear floods, the English plan of placing arches beneath the roadway becomes impracticable, though I still think that there is vast room for improvement here, not excepting Mr. Howe's very creditable arrangement of braces, iron rods and abutting blocks.

It is common in Europe to pave wooden bridges, and I believe the bridge in the city of Providence was paved, and found to answer well. Where the traffic is great, the plank wear out fast, and a thin coating of loose gravel is very injurious, by admitting moisture and heat to the plank and preventing evaporation. If the plank be covered, the materials should be put on in sufficient quantity to prevent the percolation of the water. On railway bridges where the roadway is not subjected to the action of wheels and horses' hoofs, a thick coating of gravel and tar does very well. Where the frame work of a bridge is not covered in, it is a good plan to put on two or three coats of paint and sand which serves as a protection in some degree against fire as well as against the weather. I look forward with much interest to the results of Kyan's, Earle's and Payne's process for preserving timber, and

certainly appears that sufficient time has elapsed to test their value in some degree.



The bridge represented in the wood cut was designed in the autumn of 1841, and built during the following winter, to replace a lattice bridge destroyed by fire. The span is 70 feet, the rise 15 feet, outside width 20 feet. There are 4 arches 12 by 20 inches, formed of 10 two inch planks, planed, covered with vegetable tar, and bolted together with 2 three-fourths inch bolts every 4 feet. The vertical rods are of one and one-fourth inch iron, and the arches and floor are braced horizontally in the usual manner. The arrangement of the floor timbers is not good, but I was compelled to suit the design to certain dimensions of material on hand.

For engines, exceeding 7 to 8 tons in weight, the arches should be 24 inches deep, and with the most suitable dimensions of longitudinal and floor timbers, 3 arches would be sufficient for 10 or 12 ton engines. It will be seen at a glance that the great difficulty is to give sufficient stiffness in the centre. The object was to guard against fire, and the arches and strings were to have been covered with sheet iron. They were, however, protected by three coats of paint and sand, and with the heavy covering of clay, and gravel on the floor, the bridge is tolerably

safe from the incendiary—a more formidable, and perhaps more frequent enemy than the sparks from the engine.

Arches built in this manner have a strong tendency to retain their form. During the erection of the above bridge a sudden rise in the river disturbed the centering and forced the arches back at the springing, increasing the span as it were, but on restoring the centering to its position the arches sprung back to their original form with great violence. Though built in the plainest manner and of trifling span, the effect is greater than can well be believed without inspection. The use of plank arches is of old date in this country for suspending the road way, and there are fine specimens of large arches of plank under the roadway in Weale's bridges. The arrangement of the spandrels is however different, and I believe the arches described above were put together in a more substantial manner; no wooden pins were used, the plank were only ten inches thick and well planed and firmly bolted together without felt.

This bridge has little or no thrust, is far superior in appearance to any wooden bridge I have seen, admits of considerable ornament and is well adapted to sites, where civilization has had sufficient time to produce its legitimate effects on the taste and feelings of the community.

*New York, January, 1844.*

W. R. C.

For the American Railroad Journal and Mechanics' Magazine.

#### FAILURE OF RAILWAYS.

When Mr. Ellet first advanced his unheard of doctrine, proposing to make the cost of railroads and their fixtures, with an eye to the business which they were likely to obtain—urging the propriety of making little roads for little business, and large and strong roads for a heavy trade—a very learned critic assailed the monstrous idea in your Journal of January 1st, 1842. From this valuable paper I copy the following paragraph :

" Still another comparison may be made between the Schuylkill canal, which costs \$38,000 per mile without boats, and the Philadelphia and Pottsville railway, which costs \$50,000 per mile, including cars and motive power. Is it not this additional cost which makes it the superior and cheaper work of the two ? "

It will doubtless be gratifying to your correspondent, to learn that this great railway has augmented its superiority, since that period, to the amount of \$26,000 per mile. The present cost of the railway appears, by the company's last report, to be no less than \$7,119,295 51, or, in round numbers, \$76,000 per mile.

Its great merit was its great cost. *It has increased this merit in the brief space of two years fifty per cent.*

The road is not yet finished, but the company have just obtained a loan of \$1,000,000, with which they hope to complete it. This sum, added to the interest now unpaid, and the current year's interest, will add \$1,500,000 to the present cost of the work, or, in round numbers again, \$16,000 per mile. This is equivalent to an additional increase in the merit of the road, for the present year, of 33 per cent. Its merit, accordingly, at the end of this year, will be simply that of having cost \$92,000 per mile.

Verily, Mr. Ellet was "behind the age," to use the language of your correspondent, and the Reading railroad company are fast coming up with the age.

Y.

We commence the publication, in this number of the Journal, of a very extensive series of tables for calculating quantities of excavation and embankment. These tables will be completed in the next number, and will be followed by a general description of the mode of calculating them as well as a rigorous investigation of the principles on which they are founded. They are prepared for different slopes and bases. The transverse and longitudinal inclinations of the ground are also allowed for

When completed, we shall, if sufficient inducement offer, publish them in pamphlet form, for the convenience of those who may desire to have them

separately, and we believe that they will form a valuable present to the members of the profession, who will also duly estimate the skill and industry of the gentleman by whom they have been calculated and arranged. As it is our intention to make the Journal as useful as possible to the engineer, we cheerfully contribute the additional labor and expenditure incurred on our part, in bringing forward these elaborate tables.

We cheerfully give place to the report of the Schuylkill Navigation Company, exhibiting the result of their operations for the past year. This company has been many years in very successful operation, and its stock was at one time esteemed the most productive in the country, having paid, we believe, for several years about 20 per cent. per annum; of this, however, we are not sure, as this is the first of their reports which has come under our observation. From this report it appears that the company are enlarging the capacity of the canal, to enable them to reduce their tolls still more, and thus retain the coal trade, for which, the Reading railroad has become a competitor. Competition in business, while it often produces general good by the reduction of expenses common to all, the poor as well as the rich, not unfrequently operates disadvantageously to individuals; and such has probably been the case in this instance, as the stockholders in this canal company now receive only six per cent. on their investment instead of 15 or 20 as formerly: but the competition of the railroad has reduced the cost of transportation of coal from Pottsville to Philadelphia full one dollar per ton, thus effecting an annual saving to the consumers of coal in this country, of at least one and a-half millions of dollars a year. It does not, however, follow, that the canal is to lose its business because the railroad obtains a portion of the coal trade—for otherwise—as their competition alone, if no other cause operated, would produce a large increase in the consumption. In 1834 there was 226,692 tons of coal shipped from Pottsville; the past year, 1843, it has exceeded 680,000 tons, or trebled in nine years. Of course there will be a continued increase in the business, which will require both works to extend their means for accommodating it; and our greatest apprehension is, that they will not be able, at present rates of transportation, to keep up the competition and give the shareholders a fair return for their investment; and would say to the managers of both companies, come to a fair price, say \$1.40 or \$1.50 per ton, and then let your rivalry be which shall get most business at that.

**REPORT OF THE SCHUYLKILL NAVIGATION COMPANY TO THE STOCKHOLDERS.**

The president and managers of the Schuylkill navigation company, respectfully submit to the stockholders their annual report for the year 1843, which has just ended.

The unusual lateness of the spring prevented the opening of the navigation until the 10th of April; after which it continued uninterrupted and in excellent order until closed, in December, for the winter. The supply of water has been good, rendering unnecessary a resort to the ample stores contained in the reservoirs.

**I.—OF THE STATE OF THE WORKS.**

The works generally are in good order; and the repairs required this winter are not heavy. Throughout the line of 108 miles, from Port Carbon to Philadelphia, the works are much more substantial than formerly, having been greatly improved and strengthened within the last few years, while the canal banks have attained great solidity by time. The wooden portions of the mechanical structures are the principal causes of expense for repairs.

The new dam recently erected at Fairmount, under the authority and at the expense of the city corporation, to replace the old one, which had stood twenty-two years, and had become very leaky, is an excellent piece of work,

and relieves the company's navigation, for more than five miles, from the injury caused by the defective and sunken condition of the old dam.

That pool has been the most defective part of the line, and has been the cause of more trouble and expense to the boatmen than any other. As the water could not be drawn down to deepen the channel, the construction of coffer dams has been required; and in former years several portions of the pool have been thus improved, so as to give a depth of five and a-half feet when the river is at its ordinary stage. During the past season, shallow places, amounting in the aggregate to the length of 2,288 feet, have been thus deepened; and it is believed that the boatmen will hereafter be able to pass through this pool with the same facility as the rest of the line.

Most of the dams on the lower part of the Schuylkill, where the river is large, have been rebuilt by the company within a few years, in the most substantial manner, and so as to give an increased depth of water. During the past season it has been the policy of the managers to maintain the works in the most efficient state, at as small an expense as the length and importance of the line, and the large amount of mechanical work upon it would permit; and they think that they have succeeded to a gratifying extent—as the great reduction, amounting to \$31,064 33, in the annual current expenses for repairs, salaries, and lock-tenders' wages will indicate; which has been effected without impairing the efficiency of the police of the line, or the means for the rapid passage of the boats.

The new outlet lock at the cross-cut, fourteen miles from the head of the works, has been completed this season. The foundation was laid, and the cut stone walls carried above the level of the pool in 1841, when its completion was postponed. This is now accomplished in the best manner, overcoming a lift of twelve feet two inches, which formerly required two locks.

#### II.—OF THE TRADE OF THE PAST SEASON.

The toll on coal has been retained at the rate of five mills, or half a cent, per ton per mile, at which it was fixed in 1842; and the tolls on most other articles at the former rates of three and four mills per 1,000 pounds per mile—although some have been transferred from the higher to the lower class. The highest class at the rate of six mills, which contained but a small amount of tonnage, has been abolished, and the articles placed in the other classes, so as to simplify the classification. A uniform toll of two cents per mile, has been charged on all empty boats, but no toll on any boat when the cargo which it carried paid a toll of five dollars or upwards.

The total tonnage of articles *ascending* the river, exceeds that of 1842 by ten per cent., in which there is a small increase of grain, salt, lumber and iron.

The total tonnage of miscellaneous articles *descending* the river, excluding coal, lime and lime stone, exceeds that of last year by thirteen per cent., having increased from 46,392 to 52,425 tons. This increase is mainly in grain, flour, iron and nails. In lime and lime stone descending, there has been a falling off of 15,328 tons, which is owing to a temporary fluctuation in the general amount of the trade in those articles.

The quantity of coal brought down this season is 447,058 tons—which is nine per cent. less than the trade of last year. This diminution has been caused by diverting a portion of the Schuylkill coal trade from the natural channel of the navigation, and forcing it upon the Reading railroad; which has been effected to some extent by those having the control of that work, by means of a scale of prices far below what is known upon any other railroad, and which has been repeatedly varied and reduced, for the apparent purpose of diverting the coal trade from the canal.

Notwithstanding this extraordinary competition, the pecuniary results of this year's business have been highly gratifying, and they may be briefly stated as follows:

Amount of tolls received in 1843, \$260,724 38	Current expenses for repairs, salaries	\$71,856 67
" Rents " 19,070 25	and lock tenders' wages,	
Receipts, \$279,794 63	Expenses completing new lock at	
Deduct expenses and interest, 177,573 46	cross-cut,	5,093 06
Surplus, 102,221 17	Interest account,	100,623 73
	Expenses and interest,	177,573 46

Leaving a surplus of \$102,221 17 from the business of 1843, after paying expenses and interest, and completing the new lock ; which is more than six per cent. upon the capital stock of the company.

The reduction of tolls upon the Union canal has increased the tonnage derived from that source.

The income received from rents is \$19,070 25, being \$2,070 25 more than the estimate given in the last annual report ; and the company possesses a large amount of valuable water power, still undisposed of.

The whole number of Schuylkill canal boats in use in 1843, has been about 800—of which 770 have been registered as passing the Fairmount locks. Of these, 278 are covered boats, adapted to the direct trade from Pottsville to New York : 434 are open coal boats, and 58 lime boats and miscellaneous.

The direct trade to New York amounts this year to 119,972 tons, taken through the Delaware and Raritan canal, consisting of 2,045 boat loads—averaging 58 tons 13 cwt. each.

### III.—OF THE FINANCES OF THE COMPANY.

The present amount of the loans of the company is \$1,791,020 19 ; and the annual interest accruing upon them, \$96,533 70. Of the \$300,000 loan of 1837, \$120,000 have been paid off in the past year, and the residue extended until the first of January, 1854.

It has been the fortune of this great work, from its commencement to the present time, to meet occasionally with obstructions and difficulties, calling for patient fortitude on the part of the stockholders.

During the last two years, the state of the trade, the general prostration of credit and confidence, together with an extraordinary competition, occurring at a period when loans were falling due, which under ordinary circumstances could have been easily renewed, have obliged the board to apply the revenue of the company, diminished by the reduction of the toll, to the payment of debt ; and thus the two years have necessarily passed without a dividend, though the income afforded an annual surplus of more than six per cent. There could be no hesitation about the obligation so to apply the revenue. The debt due was a demand of justice, to be paid to the utmost extent of the company's means. The stockholders have borne this privation with their usual firmness ; and the profits which have been disbursed by the company, since the 1st of January, 1841, besides paying all current charges and interest, and \$105,089 71 for new work, damages and real estate, have reduced the permanent debt of the company \$321,156 03, and the annual interest \$17,262 30.

Thus in 1841, the permanent debt was	\$2,112,176 22
Now it is only	1,791,020 19
Difference,	\$321,156 03
In Sept'r and Dec'r, 1841, the interest payable was equal to per annum,	\$113,796 00
Now it is	96,533 70
Difference,	\$17,262 30

Each share of stock has therefore been relieved from a debt to the amount of \$9 64, and is intrinsically worth \$9 64 more than it would have been if such payment had not been made; and the saving in the annual interest is equal to more than one per cent. per annum upon the whole capital stock.

By reducing, at the same time, the current expenses, these two items, (interest and expenses,) formerly amounting to \$224,596 a year, are now, when the accounts are similarly stated, but \$172,480.

If the revenue of the year 1844 should be equal to that of 1843, and the same system be pursued, there will be a further reduction of the permanent debt, so that the capital stock and debt will be made nearly equal, and will amount together to about \$3,350,000, and the annual interest will be further reduced. Whether or not this course will be the most expedient, must depend upon future circumstances. If it should not, still there will be an annual appropriation to a sinking fund, for the payment of the debt, sufficient to extinguish the whole of it in a reasonable time—an end which ought steadily to be kept in view.

A loan of \$153,887 19, at six per cent., will become due on the 1st day of December, 1844; and a loan of \$141,100, at five per cent., on the 1st of January, 1845; and an ordinance has been prepared, and will be submitted to the stockholders, to give to the board of managers the necessary power to provide for these loans.

#### IV.—OF THE CAPACITY OF THE NAVIGATION.

The total tonnage transported upon the Schuylkill navigation since it was first opened for public use, is nearly equal to eight millions of tons; and the line has been in better working order during the past season than ever before. The waters of the river, which nature constantly renews, do not perish in the using, like artificial roads.

In the year 1841, in 29 weeks, the canal carried 737,517 tons, which for the usual season of 35 weeks, would be equal to 890,106 tons. And this is far below the capacity of the existing navigation, the present practical limit of which may be estimated at about a million and a half of tons descending and which may easily be much increased.

The work is a public highway; the boats upon it belong to individuals; and any one, on paying very moderate tolls, and conforming to a few simple regulations, is entitled to use it, all times, and in such way as may best suit his convenience. This has made it of great importance to the counties through which it passes, and to the people who live along its borders, who have found in the canal a most valuable home market for their produce. At the same time, it has left the company without the power of regulating the rates of freight, although they have largely exercised their right of reducing the tolls. For several years after the canal was opened, the load of a canal boat was about 25 tons, and the time required for a trip from Pottsville to Philadelphia, and back, was about two weeks.

A large part of the boats now carry 60 tons; and the trip is often made in eight days. The increasing of the loads, and the shortening of the time, are both important elements in reducing the expense of transportation. The former is mainly due to the increased depth of water, and the latter to the doubling of the locks, and the improvement of the towing paths. Considerable improvements have also been made in the construction of the boats.

The load which a boat can carry being equal to the difference between the weight of the boat and the weight of the water which it displaces when loaded, the lightest boat, other things being equal, can carry the largest load. Many persons interested in the coal trade, having expressed a strong desire that a boat adapted to the Schuylkill navigation should be built of iron, sev-

eral stockholders subscribed to the fund for the purpose of building such an iron boat, which has been done by L. P. Morris & Co., of this city; and the boat, which is of good model and very substantial, has made a successful trip to the coal region and back; but as she has proved to be but little lighter than a good wooden boat of similar dimensions, her tonnage is not materially more.

(To be continued.)

**Manomotive Railway Carriage.**—We are informed that a machine of this description is in use upon the London and Croydon railway, having been lately made for Mr. Gregory, the resident engineer, by Mr. George England, engineer, well known as the inventor of the patent traversing screw jack, and other important improvements. The machine is light and elegant in appearance, and will carry seven or eight persons at the rate of eighteen miles an hour. It was propelled on Monday week by Mr. Roberts, deputy chairman of the Croydon company, and Mr. England, the inventor, from the New Cross Station to the Dartmouth Arms—a distance of three miles up an inclined plane of 1 in 100, in seventeen minutes, and upon the level line at the rate of twenty miles an hour. It is intended to be used by Gregory and his assistants to traverse the line, inspecting any repairs or other works going on connected with the railway; and will, in our opinion, be found particularly useful for this purpose, and more especially so in connection with those works upon the line which it is necessary to carry on during the night. We have no doubt that these machines will come into general use, as they will effect a considerable saving to the company in the expense of running an engine for the purposes which they will supply. We hail with pleasure anything calculated to reduce that most important item in railway accounts—the locomotive expenses.—[Railway Times.]

**Stuffing Boxes.**—A great economy in the tallow usually required for stuffing boxes is effected by encircling the rod by a piece of sheet brass, the joint being a diagonal one, and the bottom edge turned up all round like the brim of a hat. This brass tube is packed with hemp at the back, and extends from the bottom of the stuffing box to within three quarters of an inch of the top, so as to admit of the gland being tightened, and the upper edge of the tube is bevelled off, so as to prevent the packing from catching upon it. This improvement is due to the engineer of the Tagus, in which vessel it has been in successful operation for many months past; its effect is to keep the piston rods in the best possible condition, and to effect a saving of three-fourths of the tallow.—[Artizan.]

**English Locomotives on the Continent.**—In Germany, says a Leipzig paper, exclusive of Austria, there are 180 locomotives of English manufacture running. Of these, Messrs. Robert Stephenson & Co. made 81, which are distributed over 14 lines of railway; Sharp & Co. made 49 which are running on 10 lines; Turner & Co. made 11; Rothwell, 10; Langridge & Co., 5; Forrester & Co., 5; Kirtly, 5; Tayleur & Co., 1; Bury & Co., 4; Fenton & Co., 2; Gaskell, 2; Rennie, 1; Hawthorn, 1; Total 180.

**Helix Propeller.**—Some account was lately given to the Paris Academy of Sciences of experiments made with helix propeller on the Napoleon steamboat. The engines were of 120 horse power, and the results were that she would go 10 knots an hour by steam alone in calm weather, and that in a voyage from Havre to Cherbourg, and from Cherbourg to Southampton, against a strong north wind and heavy sea, she went, with her lofty mast, from 8 to 9 knots an hour. Under the same circumstances, the reporter alleges that ordinary paddles would not have exceeded 5 to 6 knots. With the assistance of the wind she went 12 1-2 and 13 knots in the sea. The reporter also affirms, that this vessel, the Napoleon, beat the Pluto, fitted with the Archimedean screw, half a knot an hour; and that the Pluto beat the Archimedean nearly a knot an hour. Of course therefore, this Napoleon would beat the Archimedean 1 1-2 knots an hour.—[Herapath's Journal.]

**Profitable Patent.**—The *Mining Journal* remarks that it is a curious fact in scientific discovery, that the most profitable invention that was ever patented in this or any other country accidentally arose out of an application to Government to admit sugar for Agricultural purposes. The government applied to Mr. Howard, the accomplished chemist, brother to the late duke of Norfolk, to try some experiments for the purpose of ascertaining if sugar could be so effectually adulterated that it could not be again converted into culinary uses. For this purpose he mixed all kinds of noxious materials with it, but the question remained whether they could be again separated, and in the experiments to ascertain this, he discovered that not only could they be separated, but the sugar was better and purer. Out of this arose Howard's patent for sugar refining and the use of the vacuum pan; the annual nett income of which, from licences granted for its use, at the rate of 1s. per cwt., yielding in some years between £20,000 and £30,000. One house in London alone paid £4,000 per annum.

TABLE No. I.  
SLOPE  $\frac{1}{2}$  TO 1.  
CONTENT FOR AVERAGE DEPTHS, BASE 15 FEET.

Feet	0 c. yds.	1 c. yds.	2 c. yds.	3 c. yds.	4 c. yds.	5 c. yds.	6 c. yds.	7 c. yds.	8 c. yds.	9 c. yds.
0	0	6	11	17	23	28	34	40	46	51
1	57	63	69	75	81	87	95	100	106	112
2	119	125	131	138	144	150	157	163	170	177
3	183	190	197	203	210	217	224	231	238	245
4	252	259	266	273	280	287	295	302	309	317
5	324	331	339	346	354	362	369	377	385	392
6	400	408	416	423	431	439	447	455	463	471
7	480	486	496	504	512	521	529	538	546	554
8	563	571	580	589	597	606	615	623	632	641
9	650	659	668	677	686	695	704	713	722	731
10	741	750	759	769	777	786	796	806	816	826
11	835	845	854	864	874	884	894	903	913	923
12	933	943	953	963	974	984	994	1,004	1,014	1,025
13	1,033	1,046	1,056	1,066	1,077	1,087	1,098	1,109	1,119	1,130
14	1,141	1,151	1,162	1,173	1,184	1,195	1,206	1,217	1,228	1,239
15	1,250	1,261	1,272	1,283	1,295	1,306	1,317	1,329	1,340	1,351
16	1,363	1,374	1,386	1,396	1,409	1,421	1,432	1,444	1,456	1,468
17	1,480	1,491	1,503	1,515	1,527	1,539	1,551	1,563	1,576	1,588
18	1,600	1,612	1,624	1,637	1,649	1,662	1,674	1,686	1,699	1,711
19	1,724	1,737	1,749	1,762	1,775	1,787	1,800	1,813	1,826	1,839
20	1,852	1,865	1,878	1,891	1,904	1,917	1,930	1,943	1,957	1,970
21	1,983	1,997	2,010	2,023	2,037	2,050	2,064	2,078	2,091	2,105
22	2,118	2,132	2,146	2,160	2,174	2,187	2,201	2,215	2,229	2,243
23	2,257	2,271	2,286	2,300	2,314	2,328	2,342	2,357	2,371	2,386
24	2,400	2,414	2,429	2,443	2,458	2,473	2,487	2,502	2,517	2,531
25	2,546	2,561	2,576	2,591	2,606	2,621	2,636	2,651	2,666	2,681
26	2,696	2,711	2,727	2,742	2,757	2,773	2,788	2,803	2,819	2,834
27	2,850	2,866	2,881	2,897	2,912	2,928	2,944	2,960	2,976	2,991
28	3,007	3,023	3,039	3,055	3,071	3,087	3,103	3,120	3,136	3,152
29	3,168	3,185	3,201	3,217	3,234	3,250	3,267	3,283	3,300	3,317
30	3,333	3,350	3,367	3,383	3,400	3,417	3,434	3,451	3,468	3,485
31	3,502	3,519	3,536	3,553	3,570	3,587	3,605	3,622	3,639	3,657
32	3,674	3,691	3,709	3,726	3,744	3,762	3,779	3,797	3,814	3,832
33	3,850	3,868	3,886	3,903	3,921	3,939	3,957	3,975	3,993	4,011
34	4,029	4,048	4,066	4,084	4,102	4,121	4,139	4,157	4,176	4,194
35	4,213	4,231	4,250	4,269	4,287	4,306	4,325	4,343	4,362	4,381
36	4,400	4,419	4,438	4,457	4,476	4,495	4,514	4,533	4,552	4,571
37	4,591	4,610	4,629	4,649	4,668	4,687	4,707	4,726	4,746	4,766
38	4,785	4,805	4,824	4,844	4,864	4,884	4,904	4,923	4,943	4,963
39	4,983	5,003	5,023	5,043	5,064	5,084	5,104	5,124	5,144	5,165
40	5,183	5,205	5,226	5,246	5,267	5,287	5,308	5,329	5,349	5,370
41	5,391	5,411	5,432	5,453	5,474	5,495	5,516	5,537	5,558	5,579
43	5,600	5,621	5,642	5,663	5,685	5,706	5,727	5,749	5,770	5,791
43	5,813	5,834	5,856	5,878	5,899	5,921	5,942	5,964	5,986	6,009
44	6,030	6,051	6,073	6,095	6,117	6,139	6,161	6,183	6,206	6,228
45	6,250	6,279	6,317	6,339	6,361	6,384	6,406	6,429	6,451	
46	6,474	6,497	6,519	6,542	6,565	6,587	6,610	6,633	6,656	6,679
47	6,703	6,725	6,748	6,771	6,794	6,817	6,840	6,863	6,887	6,910
48	6,933	6,957	6,980	7,003	7,027	7,050	7,074	7,098	7,121	7,145
49	7,168	7,192	7,216	7,240	7,264	7,287	7,311	7,335	7,359	7,383
50	7,407	7,431	7,456	7,480	7,504	7,528	7,552	7,577	7,601	7,625
51	7,650	7,674	7,699	7,723	7,748	7,773	7,797	7,822	7,847	7,871
52	7,896	7,921	7,946	7,971	7,996	8,021	8,046	8,071	8,096	8,121
53	8,146	8,171	8,197	8,222	8,247	8,273	8,298	8,324	8,349	8,374
54	8,400	8,426	8,451	8,477	8,502	8,528	8,554	8,580	8,606	8,631
55	8,657	8,683	8,709	8,735	8,761	8,787	8,814	8,840	8,866	8,892
56	8,918	8,945	8,971	8,997	9,024	9,050	9,077	9,103	9,130	9,157
57	9,183	9,210	9,237	9,263	9,290	9,317	9,344	9,371	9,398	9,425
58	9,452	9,479	9,506	9,533	9,560	9,587	9,615	9,642	9,669	9,697
59	9,724	9,751	9,779	9,806	9,834	9,862	9,889	9,917	9,944	9,972
60	10,000	10,028	10,056	10,083	10,111	10,139	10,167	10,195	10,223	10,251

TABLE No. II.

SLOPE  $\frac{1}{2}$  TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 18 FEET.

Feet.	0	1	2	3	4	5	6	7	8	9
	c. yds.									
0	0	7	13	20	27	34	41	48	55	61
1	69	76	83	90	97	104	111	119	126	133
2	141	148	156	163	171	178	186	193	201	209
3	217	224	232	240	248	256	264	272	280	288
4	296	304	312	321	329	337	346	354	363	371
5	380	388	397	405	414	423	431	440	449	458
6	467	476	485	493	503	512	521	530	539	548
7	557	567	576	585	595	604	614	623	633	642
8	652	661	671	681	691	700	710	720	730	740
9	750	760	770	780	790	800	811	821	831	841
10	852	862	873	883	894	904	915	925	936	947
11	957	968	979	990	1,001	1,012	1,023	1,034	1,046	1,056
12	1,067	1,078	1,089	1,100	1,111	1,123	1,134	1,145	1,156	1,168
13	1,180	1,191	1,203	1,214	1,226	1,237	1,249	1,261	1,273	1,284
14	1,296	1,308	1,320	1,332	1,344	1,356	1,368	1,380	1,392	1,404
15	1,417	1,429	1,441	1,453	1,466	1,478	1,491	1,503	1,516	1,528
16	1,541	1,553	1,566	1,579	1,591	1,604	1,617	1,630	1,643	1,656
17	1,669	1,681	1,695	1,708	1,721	1,734	1,747	1,760	1,773	1,787
18	1,800	1,813	1,827	1,841	1,854	1,867	1,881	1,894	1,908	1,921
19	1,935	1,924	1,963	1,976	1,990	2,004	2,018	2,032	2,046	2,060
20	2,074	2,088	2,102	2,116	2,131	2,145	2,159	2,173	2,188	2,202
21	2,217	2,231	2,246	2,260	2,275	2,289	2,304	2,319	2,333	2,348
22	2,363	2,378	2,393	2,408	2,423	2,437	2,453	2,468	2,483	2,498
23	2,513	2,528	2,543	2,559	2,574	2,589	2,605	2,620	2,636	2,651
24	2,667	2,688	2,698	2,713	2,729	2,745	2,761	2,776	2,792	2,808
25	2,824	2,840	2,856	2,872	2,888	2,904	2,920	2,936	2,952	2,969
26	2,985	3,001	3,018	3,034	3,051	3,067	3,084	3,100	3,117	3,133
27	3,150	3,167	3,183	3,200	3,217	3,234	3,251	3,268	3,285	3,301
28	3,319	3,336	3,353	3,370	3,387	3,404	3,421	3,439	3,456	3,473
29	3,491	3,508	3,526	3,543	3,561	3,578	3,596	3,613	3,631	3,649
30	3,667	3,684	3,702	3,720	3,738	3,756	3,774	3,792	3,810	3,828
31	3,846	3,864	3,883	3,901	3,919	3,937	3,956	3,974	3,993	4,011
32	4,030	4,048	4,067	4,085	4,104	4,123	4,141	4,160	4,179	4,198
33	4,217	4,236	4,255	4,273	4,293	4,312	4,331	4,350	4,369	4,388
34	4,407	4,427	4,446	4,465	4,485	4,504	4,524	4,543	4,563	4,582
35	4,602	4,621	4,641	4,661	4,681	4,700	4,720	4,740	4,760	4,780
36	4,800	4,820	4,840	4,860	4,880	4,900	4,921	4,941	4,961	4,981
37	5,002	5,022	5,043	5,063	5,084	5,104	5,125	5,145	5,166	5,187
38	5,207	5,228	5,249	5,270	5,291	5,312	5,333	5,353	5,375	5,396
39	5,417	5,438	5,459	5,480	5,501	5,523	5,544	5,565	5,587	5,608
40	5,630	5,651	5,673	5,694	5,716	5,737	5,759	5,781	5,803	5,824
41	5,846	5,868	5,890	5,912	5,934	5,956	5,978	6,000	6,022	6,044
42	6,067	6,089	6,111	6,133	6,156	6,178	6,201	6,223	6,246	6,268
43	6,291	6,313	6,336	6,359	6,381	6,404	6,427	6,450	6,473	6,496
44	6,519	6,541	6,565	6,588	6,611	6,634	6,657	6,680	6,703	6,727
45	6,750	6,773	6,797	6,820	6,844	6,867	6,891	6,914	6,938	6,961
46	6,985	7,009	7,033	7,056	7,080	7,104	7,128	7,152	7,176	7,200
47	7,224	7,248	7,272	7,296	7,321	7,345	7,369	7,393	7,418	7,442
48	7,467	7,491	7,516	7,540	7,565	7,589	7,614	7,639	7,663	7,688
49	7,712	7,738	7,763	7,788	7,813	7,837	7,863	7,888	7,913	7,938
50	7,963	7,988	8,013	8,039	8,064	8,089	8,115	8,140	8,166	8,191
51	8,217	8,242	8,268	8,293	8,319	8,345	8,371	8,396	8,422	8,448
52	8,474	8,500	8,526	8,553	8,578	8,604	8,630	8,656	8,683	8,709
53	8,735	8,761	8,788	8,814	8,841	8,867	8,894	8,920	8,947	8,973
54	9,000	9,027	9,053	9,080	9,107	9,134	9,161	9,188	9,215	9,241
55	9,269	9,296	9,323	9,350	9,377	9,404	9,431	9,459	9,486	9,513
56	9,541	9,568	9,596	9,623	9,651	9,678	9,706	9,733	9,761	9,789
57	9,817	9,844	9,872	9,899	9,927	9,955	9,984	10,012	10,040	10,068
58	10,096	10,124	10,153	10,181	10,209	10,237	10,266	10,294	10,323	10,351
59	10,380	10,408	10,437	10,465	10,494	10,523	10,551	10,580	10,609	10,638
60	10,667	10,696	10,725	10,753	10,783	10,812	10,841	10,870	10,899	10,928

TABLE No. III.  
SLOPE  $\frac{1}{2}$  TO 1.  
CONTENT FOR AVERAGE DEPTHS, BASE 25 FEET.

Feet	0	1	2	3	4	5	6	7	8	9
	c. yds.									
0	0	9	19	28	37	47	56	66	75	85
1	94	104	114	123	133	143	153	163	173	183
2	193	203	213	223	233	243	253	264	274	284
3	294	305	315	326	336	347	357	368	378	389
4	400	411	422	432	443	454	465	476	487	498
5	509	520	532	543	554	565	577	588	599	611
6	622	634	645	657	668	680	692	703	715	727
7	739	751	763	775	787	799	811	823	835	847
8	859	872	884	896	908	921	933	946	958	971
9	983	996	1,008	10,21	1,034	1,047	1,059	1,072	1,085	1,098
10	1,111	1,124	1,137	1,150	1,163	1,176	1,190	1,203	1,216	1,229
11	1,243	1,256	1,269	1,283	1,296	1,310	1,323	1,337	1,350	1,364
12	1,378	1,391	1,405	1,419	1,433	1,447	1,461	1,475	1,489	1,503
13	1,517	1,531	1,545	1,559	1,573	1,587	1,602	1,616	1,630	1,645
14	1,659	1,674	1,688	1,703	1,717	1,732	1,746	1,761	1,776	1,791
15	1,806	1,820	1,835	1,850	1,865	1,880	1,895	1,910	1,925	1,940
16	1,956	1,971	1,986	2,001	2,017	2,032	2,047	2,063	2,078	2,094
17	2,109	2,125	2,140	2,156	2,172	2,187	2,203	2,219	2,235	2,251
18	2,267	2,283	2,299	2,315	2,331	2,347	2,363	2,379	2,395	2,411
19	2,428	2,444	2,460	2,477	2,493	2,510	2,526	2,543	2,559	2,576
20	2,593	2,609	2,626	2,643	2,660	2,676	2,693	2,710	2,727	2,744
21	2,761	2,778	2,795	2,812	2,830	2,847	2,864	2,881	2,899	2,916
22	2,933	2,951	2,968	2,986	3,003	3,021	3,038	3,056	3,074	3,091
23	3,109	3,127	3,145	3,163	3,181	3,199	3,217	3,235	3,253	3,271
24	3,289	3,307	3,325	3,343	3,362	3,380	3,398	3,417	3,435	3,454
25	3,472	3,491	3,509	3,528	3,546	3,565	3,584	3,603	3,622	3,640
26	3,659	3,678	3,697	3,716	3,735	3,754	3,773	3,792	3,812	3,831
27	3,850	3,869	3,889	3,908	3,927	3,947	3,966	3,986	4,005	4,025
28	4,044	4,064	4,084	4,103	4,123	4,143	4,163	4,183	4,203	4,223
29	4,243	4,263	4,283	4,303	4,323	4,343	4,363	4,383	4,404	4,424
30	4,444	4,465	4,485	4,506	4,526	4,547	4,567	4,588	4,608	4,629
31	4,650	4,671	4,692	4,712	4,733	4,754	4,775	4,796	4,817	4,838
32	4,858	4,880	4,902	4,923	4,944	4,965	4,987	5,008	5,029	5,051
33	5,072	5,094	5,115	5,137	5,158	5,180	5,202	5,223	5,245	5,267
34	5,289	5,311	5,333	5,355	5,377	5,399	5,421	5,443	5,465	5,487
35	55,09	5,531	5,554	5,576	5,598	5,621	5,643	5,666	5,688	5,711
36	5,733	5,756	5,778	5,801	5,824	5,847	5,870	5,892	5,915	5,938
37	5,961	5,984	6,007	6,030	6,053	6,076	6,099	6,123	6,146	6,169
38	6,193	6,216	6,239	6,263	6,286	6,310	6,333	6,357	6,380	6,404
39	6,428	6,451	6,475	6,499	6,523	6,547	6,571	6,595	6,619	6,643
40	6,667	6,691	6,715	6,739	6,763	6,787	6,812	6,836	6,860	6,885
41	6,909	6,934	6,958	6,983	7,007	7,032	7,057	7,081	7,106	7,131
42	7,156	7,180	7,205	7,230	7,255	7,280	7,305	7,330	7,355	7,380
43	7,406	7,431	7,456	7,481	7,507	7,532	7,557	7,583	7,608	7,634
44	7,659	7,685	7,710	7,736	7,762	7,787	7,813	7,839	7,865	7,891
45	7,917	7,943	7,969	7,995	8,021	8,047	8,073	8,099	8,125	8,151
46	8,178	8,204	8,230	8,257	8,283	8,310	8,336	8,363	8,389	8,416
47	8,442	8,469	8,496	8,523	8,550	8,576	8,603	8,630	8,657	8,684
48	8,711	8,738	8,765	8,792	8,820	8,847	8,874	8,901	8,929	8,956
49	8,983	9,011	9,038	9,066	9,093	9,121	9,148	9,176	9,204	9,231
50	9,259	9,287	9,315	9,343	9,371	9,399	9,427	9,455	9,483	9,511
51	9,539	9,567	9,595	9,623	9,652	9,680	9,708	9,737	9,765	9,794
52	9,822	9,851	9,879	9,908	9,936	9,965	9,994	10,023	10,052	10,080
53	10,109	10,138	10,167	10,196	10,225	10,254	10,283	10,312	10,342	10,371
54	10,400	10,429	10,459	10,488	10,517	10,547	10,576	10,606	10,635	10,665
55	10,694	10,724	10,754	10,783	10,813	10,843	10,873	10,903	10,933	10,963
56	10,993	11,023	11,053	11,083	11,113	11,143	11,173	11,203	11,234	11,264
57	11,294	11,325	11,355	11,386	11,416	11,447	11,477	11,508	11,538	11,569
58	11,600	11,631	11,662	11,692	11,723	11,754	11,785	11,816	11,847	11,878
59	11,909	11,940	11,972	12,003	12,034	12,065	12,097	12,128	12,159	12,191
60	12,222	12,254	12,285	12,317	12,348	12,380	12,412	12,443	12,475	12,507

TABLE No. IV.  
SLOPE  $\frac{1}{2}$  TO 1.  
CONTENT FOR AVERAGE DEPTHS, BASE 28 FEET.

Feet.	0 c. yds.	1 c. yds.	2 c. yds.	3 c. yds.	4 c. yds.	5 c. yds.	6 c. yds.	7 c. yds.	8 c. yds.	9 c. yds.
0	0	10	21	31	42	52	63	73	84	95
1	106	116	127	138	149	160	171	182	193	204
2	215	226	237	248	260	271	282	293	305	316
3	328	339	341	352	364	376	387	399	411	423
4	444	456	468	480	492	504	516	528	540	553
5	565	577	589	602	614	626	639	651	664	666
6	689	701	714	727	740	752	765	778	791	804
7	817	830	843	856	869	882	895	908	922	935
8	948	961	975	988	1,002	1,015	1,029	1,042	1,056	1,070
9	1,083	1,097	1,111	1,125	1,138	1,152	1,166	1,180	1,194	1,208
10	1,222	1,236	1,250	1,265	1,279	1,293	1,307	1,322	1,336	1,350
11	1,365	1,379	1,394	1,408	1,423	1,437	1,452	1,467	1,482	1,496
12	1,511	1,526	1,541	1,556	1,571	1,586	1,601	1,616	1,631	1,646
13	1,661	1,676	1,692	1,707	1,722	1,737	1,753	1,768	1,784	1,799
14	1,815	1,830	1,846	1,862	1,877	1,893	1,909	1,925	1,940	1,956
15	1,972	1,988	2,004	2,020	2,036	2,052	2,068	2,085	2,101	2,117
16	2,133	2,150	2,166	2,182	2,199	2,215	2,232	2,248	2,265	2,281
17	2,298	2,315	2,332	2,348	2,365	2,382	2,399	2,416	2,433	2,450
18	2,467	2,484	2,501	2,518	2,535	2,552	2,570	2,587	2,604	2,621
19	2,639	2,656	2,674	2,691	2,709	2,726	2,744	2,762	2,779	2,797
20	2,815	2,833	2,850	2,868	2,886	2,904	2,922	2,940	2,958	2,976
21	2,994	3,013	3,031	3,049	3,067	3,086	3,104	3,122	3,141	3,159
22	3,178	3,196	3,215	3,233	3,252	3,271	3,290	3,308	3,327	3,346
23	3,365	3,384	3,403	3,422	3,441	3,460	3,479	3,498	3,517	3,536
24	3,556	3,575	3,594	3,614	3,633	3,652	3,672	3,691	3,711	3,730
25	3,750	3,770	3,789	3,809	3,829	3,849	3,868	3,888	3,908	3,928
26	3,948	3,968	3,988	4,008	4,028	4,049	4,069	4,089	4,109	4,130
27	4,150	4,170	4,191	4,211	4,232	4,252	4,273	4,293	4,314	4,335
28	4,356	4,376	4,397	4,418	4,439	4,460	4,481	4,502	4,523	4,544
29	4,565	4,586	4,607	4,628	4,650	4,671	4,692	4,713	4,735	4,756
30	4,778	4,799	4,821	4,842	4,864	4,886	4,907	4,929	4,951	4,973
31	4,994	5,016	5,038	5,060	5,082	5,104	5,126	5,148	5,170	5,193
32	5,215	5,237	5,259	5,282	5,304	5,326	5,349	5,371	5,394	5,416
33	5,439	5,461	5,484	5,507	5,530	5,552	5,575	5,598	5,621	5,644
34	5,667	5,690	5,713	5,736	5,759	5,782	5,805	5,828	5,852	5,875
35	5,898	5,921	5,945	5,968	5,992	6,015	6,039	6,062	6,086	6,110
36	6,133	6,157	6,181	6,205	6,228	6,252	6,276	6,300	6,324	6,348
37	6,372	6,396	6,420	6,445	6,469	6,493	6,517	6,542	6,566	6,590
38	6,615	6,639	6,664	6,688	6,713	6,737	6,762	6,787	6,812	6,836
39	6,861	6,886	6,911	6,936	6,961	6,986	7,011	7,036	7,061	7,086
40	7,111	7,136	7,162	7,187	7,212	7,237	7,263	7,288	7,314	7,339
41	7,365	7,390	7,416	7,442	7,467	7,493	7,519	7,545	7,570	7,596
42	7,622	7,648	7,674	7,700	7,726	7,752	7,778	7,805	7,831	7,857
43	7,883	7,910	7,936	7,962	7,989	8,015	8,042	8,068	8,095	8,121
44	8,148	8,175	8,202	8,228	8,255	8,282	8,309	8,336	8,363	8,390
45	8,417	8,444	8,471	8,498	8,525	8,552	8,580	8,607	8,634	8,661
46	8,689	8,716	8,744	8,771	8,799	8,826	8,854	8,882	8,909	8,937
47	8,965	8,993	9,020	9,048	9,076	9,104	9,132	9,160	9,188	9,216
48	9,244	9,273	9,301	9,329	9,357	9,386	9,414	9,442	9,471	9,499
49	9,528	9,556	9,585	9,613	9,642	9,671	9,700	9,728	9,757	9,786
50	9,815	9,844	9,873	9,902	9,931	9,960	9,989	10,018	10,047	10,076
51	10,106	10,135	10,164	10,193	10,223	10,252	10,282	10,311	10,341	10,370
52	10,400	10,430	10,459	10,489	10,519	10,549	10,578	10,608	10,638	10,668
53	10,698	10,728	10,758	10,788	10,818	10,849	10,879	10,909	10,939	10,970
54	11,000	11,030	12,061	11,091	11,122	11,152	11,183	11,213	11,244	11,275
55	11,306	11,336	11,367	11,398	11,429	11,460	11,491	11,522	11,553	11,584
56	11,615	11,646	11,677	11,708	11,740	11,771	11,802	11,833	11,865	11,896
57	11,928	11,959	11,991	12,022	12,054	12,086	12,117	12,149	12,181	12,213
58	12,244	12,276	11,308	12,340	12,372	12,404	12,436	12,468	12,500	12,533
59	12,565	12,597	12,629	12,662	12,694	12,726	12,759	12,791	12,824	12,856
60	12,889	12,921	12,954	12,987	13,020	13,052	13,085	13,118	13,151	13,184

TABLE No. V.

SLOPE  $\frac{1}{2}$  TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 30 FEET.

Feet	0 c. yds.	1 c. yds.	2 c. yds.	3 c. yds.	4 c. yds.	5 c. yds.	6 c. yds.	7 c. yds.	8 c. yds.	9 c. yds.
0	0	11	22	33	45	56	67	79	90	101
1	113	124	136	148	159	171	183	194	206	218
2	230	242	253	265	277	289	301	313	326	338
3	350	362	374	387	399	412	424	436	449	461
4	474	487	499	512	525	537	550	563	576	589
5	602	615	628	641	654	667	680	693	707	720
6	733	747	760	773	787	800	814	828	841	855
7	867	882	896	910	924	937	951	965	979	993
8	1,007	1,021	1,036	1,050	1,064	1,078	1,092	1,107	1,120	1,136
9	1,150	1,164	1,179	1,193	1,208	1,223	1,237	1,252	1,267	1,281
10	1,296	1,311	1,326	1,341	1,356	1,371	1,386	1,401	1,416	1,431
11	1,446	1,461	1,477	1,492	1,507	1,523	1,538	1,553	1,569	1,584
12	1,600	1,616	1,631	1,647	1,662	1,678	1,694	1,710	1,726	1,741
13	1,757	1,773	1,789	1,805	1,821	1,837	1,854	1,870	1,886	1,902
14	1,919	1,935	1,951	1,968	1,984	2,000	2,017	2,033	2,050	2,067
15	2,083	2,100	2,117	2,133	2,150	2,167	2,184	2,201	2,218	2,235
16	2,252	2,269	2,286	2,303	2,320	2,328	2,355	2,372	2,389	2,407
17	2,424	2,441	2,459	2,476	2,494	2,512	2,529	2,547	2,565	2,582
18	2,600	2,618	2,636	2,653	2,671	2,689	2,707	2,725	2,743	2,761
19	2,780	2,798	2,816	2,834	2,853	2,871	2,889	2,908	2,926	2,944
20	2,963	2,981	3,000	3,019	3,037	3,056	3,075	3,093	3,112	3,131
21	3,150	3,169	3,188	3,207	3,226	3,245	3,264	3,283	3,302	3,321
22	3,341	3,360	3,379	3,399	3,418	3,437	3,457	3,476	3,496	3,516
23	3,535	3,555	3,575	3,594	3,614	3,634	3,654	3,673	3,693	3,713
24	3,733	3,753	3,773	3,793	3,814	3,834	3,854	3,874	3,895	3,915
25	3,935	3,956	3,976	3,996	4,017	4,037	4,058	4,079	4,099	4,120
26	4,141	4,161	4,182	4,203	4,224	4,245	4,266	4,287	4,308	4,329
27	4,350	4,371	4,392	4,413	4,435	4,456	4,477	4,499	4,520	4,541
28	4,563	4,584	4,606	4,628	4,649	4,671	4,693	4,714	4,736	4,758
29	4,779	4,801	4,823	4,845	4,867	4,889	4,911	4,933	4,956	4,978
30	5,000	5,022	5,045	5,067	5,089	5,112	5,134	5,156	5,179	5,201
31	5,224	5,247	5,269	5,292	5,315	5,337	5,360	5,383	5,406	5,429
32	5,452	5,475	5,498	5,521	5,544	5,567	5,590	5,613	5,637	5,660
33	5,683	5,707	5,730	5,753	5,777	5,800	5,824	5,848	5,871	5,895
34	5,919	5,942	5,966	5,990	6,014	6,037	6,061	6,085	6,109	6,133
35	6,157	6,181	6,206	6,230	6,254	6,278	6,303	6,327	6,351	6,376
36	6,400	6,424	6,449	6,473	6,498	6,523	6,547	6,572	6,597	6,621
37	6,646	6,671	6,696	6,721	6,746	6,771	6,796	6,821	6,846	6,871
38	6,896	6,921	6,947	6,972	6,997	7,023	7,048	7,073	7,099	7,124
39	7,150	7,176	7,201	7,227	7,252	7,278	7,304	7,330	7,356	7,381
40	7,407	7,433	7,459	7,485	7,511	7,537	7,564	7,590	7,616	7,642
41	7,669	7,695	7,721	7,748	7,774	7,800	7,827	7,853	7,880	7,907
42	7,933	7,960	7,987	8,013	8,040	8,067	8,094	8,121	8,148	8,175
43	8,202	8,229	8,256	8,283	8,310	8,337	8,365	8,392	8,419	8,447
44	8,474	8,501	8,529	8,556	8,584	8,612	8,639	8,667	8,694	8,722
45	8,750	8,778	8,806	8,833	8,861	8,889	8,917	8,945	8,972	9,000
46	9,030	9,058	9,086	9,114	9,143	9,171	9,199	9,228	9,256	9,284
47	9,313	9,341	9,370	9,399	9,427	9,456	9,485	9,514	9,542	9,571
48	9,600	9,629	9,658	9,687	9,716	9,745	9,774	9,803	9,832	9,861
49	9,891	9,920	9,949	9,979	10,008	10,037	10,067	10,096	10,126	10,156
50	10,185	10,215	10,245	10,274	10,304	10,334	10,364	10,393	10,423	10,453
51	10,483	10,513	10,543	10,573	10,604	10,634	10,664	10,694	10,725	10,755
52	10,785	10,816	10,846	10,876	10,907	10,937	10,968	10,999	11,029	11,060
53	11,091	11,121	11,152	11,183	11,214	11,245	11,276	11,307	11,338	11,369
54	11,400	11,431	11,462	11,493	11,525	11,556	11,587	11,619	11,650	11,681
55	11,713	11,744	11,776	11,806	11,839	11,871	11,903	11,934	11,966	11,998
56	12,030	12,061	12,093	12,125	12,157	12,189	12,221	12,253	12,286	12,318
57	12,350	12,382	12,415	12,447	12,479	12,512	12,544	12,576	12,609	12,641
58	12,674	12,707	12,739	12,773	12,805	12,837	12,870	12,903	12,936	12,969
59	13,002	13,035	13,068	13,101	13,134	13,167	13,200	13,233	13,267	13,300
60	13,333	13,367	13,400	13,433	13,467	13,500	13,534	13,568	13,601	13,636

TABLE No. VI.

SLOPE  $\frac{1}{2}$  TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 34 FEET.

Feet	0	1	2	3	4	5	6	7	8	9
	c. yds.									
0	0	13	25	38	51	63	76	89	102	115
1	129	141	154	167	180	193	206	219	233	246
2	259	273	286	299	313	326	340	354	377	391
3	394	408	422	436	450	463	477	491	505	519
4	533	547	562	576	590	604	618	633	647	661
5	676	690	705	719	734	749	763	778	793	807
6	822	837	852	867	882	897	912	927	942	957
7	972	987	1,003	1,018	1,033	1,049	1,063	1,078	1,096	1,110
8	1,126	1,142	1,157	1,173	1,188	1,204	1,220	1,236	1,252	1,267
9	1,283	1,299	1,315	1,331	1,347	1,363	1,380	1,396	1,412	1,428
10	1,444	1,461	1,477	1,494	1,510	1,526	1,543	1,559	1,576	1,593
11	1,609	1,626	1,643	1,659	1,676	1,693	1,710	1,727	1,744	1,761
12	1,778	1,795	1,812	1,829	1,846	1,863	1,881	1,898	1,915	1,933
13	1,950	1,967	1,985	2,002	2,020	2,038	2,055	2,073	2,090	2,108
14	2,126	2,144	2,162	2,179	2,197	2,215	2,233	2,251	2,269	2,287
15	2,306	2,324	2,342	2,360	2,378	2,397	2,415	2,434	2,452	2,470
16	2,489	2,507	2,526	2,545	2,563	2,582	2,601	2,619	2,638	2,657
17	2,676	2,695	2,714	2,733	2,752	2,771	2,790	2,809	2,828	2,847
18	2,867	2,886	2,905	2,925	2,944	2,963	2,983	3,002	3,022	3,042
19	3,061	3,081	3,100	3,120	3,140	3,160	3,180	3,199	3,219	3,239
20	3,259	3,279	3,299	3,319	3,340	3,360	3,380	3,400	3,420	3,441
21	3,461	3,482	3,502	3,522	3,543	3,563	3,584	3,605	3,625	3,646
22	3,667	3,687	3,708	3,729	3,750	3,771	3,792	3,813	3,834	3,855
23	3,876	3,897	3,918	3,939	3,961	3,982	4,003	4,025	4,046	4,067
24	4,089	4,110	4,132	4,154	4,175	4,197	4,218	4,240	4,262	4,284
25	4,306	4,327	4,349	4,371	4,393	4,415	4,437	4,459	4,482	4,504
26	4,526	4,548	4,570	4,593	4,615	4,638	4,660	4,682	4,705	4,727
27	4,750	4,773	4,795	4,818	4,841	4,863	4,886	4,909	4,932	4,955
28	4,978	5,001	5,024	5,047	5,070	5,093	5,116	5,139	5,163	5,186
29	5,209	5,233	5,256	5,279	5,303	5,326	5,350	5,374	5,397	5,421
30	5,444	5,468	5,492	5,516	5,540	5,563	5,587	5,611	5,635	5,659
31	5,683	5,707	5,732	5,756	5,780	5,804	5,828	5,853	5,877	5,902
32	5,926	5,950	5,975	5,999	6,024	6,049	6,073	6,098	6,123	6,147
33	6,172	6,197	6,222	6,247	6,272	6,297	6,322	6,347	6,372	6,397
34	6,422	6,447	6,473	6,498	6,523	6,549	6,574	6,599	6,625	6,650
35	6,676	6,702	6,727	6,753	6,778	6,804	6,830	6,856	6,882	6,907
36	6,933	6,959	6,985	7,011	7,037	7,063	7,090	7,116	7,142	7,168
37	7,194	7,221	7,247	7,274	7,300	7,326	7,353	7,379	7,406	7,433
38	7,459	7,486	7,513	7,539	7,566	7,593	7,620	7,647	7,674	7,701
39	7,728	7,755	7,782	7,809	7,836	7,863	7,891	7,918	7,945	7,973
40	8,000	8,027	8,055	8,082	8,110	8,138	8,165	8,193	8,220	8,248
41	8,276	8,304	8,332	8,359	8,387	8,415	8,443	8,471	8,499	8,527
42	8,556	8,584	8,612	8,640	8,668	8,697	8,725	8,754	8,782	8,810
43	8,839	8,867	8,896	8,925	8,953	8,982	9,011	9,039	9,068	9,097
44	9,126	9,155	9,184	9,213	9,242	9,271	9,299	9,329	9,358	9,387
45	9,417	9,446	9,475	9,505	9,534	9,563	9,593	9,622	9,652	9,682
46	9,711	9,741	9,770	9,800	9,830	9,860	9,890	9,919	9,949	9,979
47	10,009	10,039	10,069	10,099	10,130	10,160	10,190	10,220	10,250	10,281
48	10,311	10,342	10,372	10,402	10,433	10,463	10,494	10,525	10,555	10,586
49	10,617	10,647	10,678	10,708	10,740	10,771	10,802	10,833	10,864	10,895
50	10,926	10,957	10,988	11,019	11,051	11,082	11,113	11,145	11,176	11,207
51	11,239	11,260	11,292	11,324	11,355	11,387	11,428	11,460	11,492	11,524
52	11,556	11,587	11,619	11,651	11,683	11,715	11,747	11,779	11,812	11,844
53	11,876	11,908	11,940	11,973	12,005	12,038	12,070	12,102	12,135	12,167
54	12,200	12,233	12,265	12,298	12,331	12,363	12,396	12,429	12,463	12,496
55	12,528	12,561	12,594	12,627	12,660	12,693	12,726	12,760	12,793	12,826
56	12,859	12,893	12,926	12,959	12,993	13,026	13,060	13,094	13,127	13,161
57	13,194	13,228	13,262	13,296	13,329	13,363	13,397	13,431	13,465	13,499
58	13,533	13,567	13,602	13,636	13,670	13,704	13,738	13,773	13,807	13,842
59	13,876	13,910	13,945	13,979	14,014	14,049	14,083	14,118	14,153	14,187
60	14,222	14,257	14,292	14,327	14,362	14,397	14,432	14,467	14,502	14,537

TABLE No. VII.  
SLOPE  $\frac{1}{2}$  TO 1.  
CORRECTION FOR DIFFERENCES OF DEPTHS.

Fest.	-0	-1	-2	-3	-4	-5	-6	-7	-8	-9
c. yds.										
1	0	0	0	0	0	0	0	0	0	0
2	1	1	1	1	1	1	1	1	1	1
3	1	2	2	2	2	2	2	2	2	2
4	2	3	3	3	3	3	3	3	3	4
5	4	4	4	4	5	5	5	5	5	5
6	6	6	6	6	6	7	7	7	7	7
7	8	8	8	8	8	8	9	9	9	10
8	10	10	10	11	11	11	11	12	12	12
9	12	13	13	13	13	14	14	15	15	15
10	15	16	16	16	17	17	17	18	18	19
11	19	19	19	20	20	20	21	21	21	22
12	22	23	23	23	24	24	25	25	26	26
13	26	27	27	27	28	28	29	29	29	30
14	30	31	31	32	32	32	33	33	34	34
15	35	35	36	36	37	37	38	38	39	39
16	40	40	41	41	42	42	43	43	44	44
17	45	45	46	46	47	47	48	48	49	49
18	50	51	51	52	52	53	53	54	55	55
19	56	56	57	57	58	59	59	60	60	61
20	62	62	63	64	64	65	65	66	67	67
21	68	69	69	70	71	71	72	73	73	74
22	75	75	76	77	77	78	78	79	80	81
23	82	82	83	84	84	85	86	87	87	88
24	89	90	90	91	92	93	93	94	95	96
25	96	97	98	99	100	100	101	102	103	104
26	104	105	106	107	108	108	109	110	111	112
27	112	113	114	115	116	117	118	118	119	120
28	121	122	123	124	124	125	126	127	128	129
29	130	131	132	132	133	134	135	136	137	138
30	139	140	141	142	143	144	144	145	146	147
31	148	149	150	151	152	153	154	155	156	157
32	158	159	160	161	162	163	164	165	166	167
33	168	169	170	171	172	173	174	175	176	177
34	178	179	181	182	183	184	185	186	187	188
35	189	190	191	192	193	194	196	197	198	199
36	200	201	202	203	204	206	207	208	209	210
37	211	212	214	215	216	217	218	219	220	222
38	223	224	225	226	228	229	230	231	232	234
39	235	236	237	238	240	241	242	243	244	246
40	247	248	249	251	252	253	254	256	257	258
41	259	261	262	263	264	266	267	268	270	271
42	272	274	275	276	277	279	280	281	283	284
43	285	287	288	289	291	292	293	295	296	297
44	299	300	301	303	304	306	307	308	310	311
45	313	314	315	317	318	319	321	322	324	325

TABLE No. VIII.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 15 FEET.

Feet	0 c. yds.	1 c. yds.	2 c. yds.	3 c. yds.	4 c. yds.	5 c. yds.	6 c. yds.	7 c. yds.	8 c. yds.	9 c. yds.
0	0	6	11	17	23	29	35	41	47	53
1	59	66	72	79	85	92	98	105	112	119
2	126	133	140	147	155	161	168	176	184	190
3	200	208	216	224	232	240	248	256	265	273
4	281	290	299	307	316	325	334	343	352	361
5	370	380	389	399	408	418	427	437	447	457
6	467	477	487	497	507	518	528	539	549	560
7	570	581	592	603	614	625	636	647	659	670
8	681	693	705	716	728	740	752	764	776	788
9	800	812	825	837	850	862	875	887	900	913
10	926	939	952	965	978	992	1,005	1,019	1,032	1,046
11	1,059	1,073	1,087	1,101	1,115	1,129	1,142	1,157	1,171	1,186
12	1,200	1,215	1,229	1,244	1,258	1,273	1,288	1,303	1,318	1,333
13	1,348	1,363	1,379	1,394	1,410	1,425	1,441	1,456	1,472	1,488
14	1,504	1,520	1,536	1,552	1,568	1,584	1,601	1,617	1,634	1,650
15	1,667	1,683	1,700	1,717	1,734	1,751	1,768	1,785	1,802	1,820
16	1,837	1,855	1,872	1,890	1,907	1,925	1,943	1,961	1,979	1,997
17	2,014	2,033	2,051	2,070	2,088	2,107	2,125	2,144	2,163	2,181
18	2,200	2,219	2,238	2,257	2,276	2,295	2,315	2,334	2,354	2,373
19	2,393	2,412	2,432	2,452	2,472	2,492	2,512	2,532	2,552	2,572
20	2,593	2,613	2,634	2,654	2,675	2,695	2,716	2,737	2,758	2,779
21	2,800	2,821	2,842	2,864	2,885	2,907	2,928	2,950	2,971	2,993
22	3,015	3,037	3,059	3,081	3,103	3,125	3,147	3,170	3,192	3,214
23	3,237	3,260	3,282	3,305	3,328	3,351	3,374	3,397	3,420	3,443
24	3,467	3,490	3,514	3,537	3,561	3,584	3,608	3,633	3,656	3,680
25	3,704	3,728	3,752	3,776	3,801	3,825	3,850	3,874	3,899	3,923
26	3,948	3,973	3,998	4,023	4,048	4,073	4,098	4,124	4,149	4,175
27	4,200	4,226	4,251	4,277	4,303	4,329	4,355	4,381	4,407	4,433
28	4,459	4,486	4,512	4,539	4,565	4,593	4,618	4,645	4,672	4,699
29	4,726	4,753	4,780	4,707	4,835	4,862	4,890	4,917	4,945	4,972
30	5,000	5,028	5,056	5,084	5,112	5,140	5,168	5,196	5,225	5,253
31	5,281	5,310	5,339	5,367	5,396	5,425	5,454	5,483	5,512	5,541
32	5,570	5,600	5,629	5,659	5,688	5,718	5,747	5,777	5,807	5,837
33	5,867	5,897	5,927	5,957	5,987	6,018	6,048	6,079	6,109	6,140
34	6,170	6,201	6,232	6,263	6,294	6,325	6,356	6,387	6,419	6,450
35	6,481	6,513	6,545	6,576	6,608	6,640	6,672	6,704	6,736	6,768
36	6,800	6,832	6,865	6,897	6,930	6,962	6,995	7,027	7,060	7,093
37	7,126	7,159	7,192	7,225	7,258	7,292	7,325	7,359	7,392	7,426
38	7,459	7,493	7,527	7,561	7,595	7,629	7,663	7,697	7,731	7,766
39	7,800	7,835	7,869	7,904	7,938	7,973	8,008	8,043	8,078	8,113
40	8,148	8,183	8,219	8,254	8,290	8,325	8,361	8,396	8,432	8,468
41	8,504	8,540	8,576	8,612	8,648	8,684	8,721	8,757	8,794	8,830
42	8,867	8,903	8,940	8,977	9,014	9,051	9,088	9,125	9,152	9,200
43	9,237	9,275	9,312	9,350	9,387	9,425	9,463	9,501	9,539	9,577
44	9,615	9,653	9,691	9,730	9,768	9,807	9,845	9,884	9,922	9,961
45	10,000	10,039	10,078	10,117	10,156	10,195	10,235	10,274	10,314	10,353
46	10,393	10,432	10,472	10,512	10,552	10,592	10,632	10,672	10,712	10,752
47	10,793	10,833	10,874	10,914	10,955	10,995	11,036	11,077	11,118	11,159
48	11,200	11,241	11,282	11,324	11,365	11,407	11,448	11,490	11,531	11,573
49	11,615	11,657	11,699	11,741	11,783	11,825	11,867	11,910	11,952	11,994
50	12,037	12,080	12,122	12,165	12,208	12,251	12,294	12,337	12,380	12,423
51	12,467	12,510	12,554	12,597	12,641	12,684	12,728	12,772	12,816	12,860
52	12,904	12,948	12,992	13,036	13,081	13,125	13,170	13,214	13,259	13,303
53	13,348	13,393	13,438	13,483	13,528	13,573	13,618	13,664	13,709	13,755
54	13,800	13,846	13,891	13,937	13,983	14,029	14,075	14,121	14,167	14,213
55	14,259	14,306	14,352	14,399	14,445	14,492	14,538	14,585	14,632	14,679
56	14,726	14,773	14,820	14,867	14,915	14,962	15,010	15,057	15,105	15,152
57	15,200	15,248	15,296	15,344	15,392	15,440	15,488	15,536	15,585	15,633
58	15,681	15,730	15,779	15,827	15,876	15,925	15,974	16,023	16,072	16,121
59	16,170	16,220	16,269	16,319	16,368	16,418	16,467	16,517	16,567	16,617
60	16,667	16,717	16,767	16,817	16,868	16,918	16,968	17,018	17,069	17,120

TABLE No. IX.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 18 FEET.

Feet.	0	1	2	3	4	5	6	7	8	9
	c. yds.									
0	0	7	13	20	27	34	41	48	56	63
1	70	78	85	93	101	108	116	124	132	140
2	148	156	165	173	181	190	198	207	216	224
3	233	242	251	260	270	279	288	297	307	316
4	326	336	345	355	365	375	385	395	405	416
5	426	436	447	457	468	479	490	500	511	522
6	533	545	556	567	578	590	601	613	625	636
7	648	660	672	684	696	708	721	733	745	758
8	770	783	796	809	821	834	847	860	874	887
9	900	913	927	940	954	968	981	996	1,009	1,023
10	1,037	1,051	1,065	1,080	1,094	1,108	1,123	1,137	1,152	1,167
11	1,181	1,196	1,211	1,226	1,241	1,257	1,272	1,287	1,302	1,318
12	1,333	1,349	1,365	1,380	1,396	1,412	1,428	1,444	1,460	1,476
13	1,493	1,509	1,525	1,542	1,558	1,575	1,592	1,609	1,625	1,642
14	1,659	1,676	1,694	1,711	1,728	1,745	1,763	1,780	1,798	1,816
15	1,833	1,851	1,869	1,887	1,905	1,923	1,941	1,960	1,978	1,996
16	2,015	2,033	2,052	2,071	2,090	2,108	2,127	2,146	2,165	2,185
17	2,204	2,223	2,242	2,262	2,281	2,301	2,321	2,340	2,360	2,380
18	2,400	2,420	2,440	2,460	2,481	2,501	2,521	2,542	2,562	2,583
19	2,604	2,625	2,645	2,666	2,687	2,708	2,730	2,751	2,772	2,793
20	2,815	2,836	2,858	2,880	2,901	2,923	2,945	2,967	2,989	3,011
21	3,033	3,056	3,078	3,100	3,123	3,145	3,168	3,191	3,214	3,236
22	3,259	3,282	3,305	3,328	3,351	3,375	3,398	3,422	3,445	3,469
23	3,493	3,516	3,540	3,564	3,598	3,622	3,646	3,670	3,697	3,721
24	3,733	3,758	3,782	3,807	3,832	3,857	3,881	3,906	3,931	3,956
25	3,981	4,007	4,032	4,057	4,083	4,108	4,134	4,160	4,186	4,211
26	4,237	4,263	4,289	4,315	4,341	4,368	4,394	4,420	4,447	4,473
27	4,500	4,527	4,554	4,580	4,607	4,634	4,661	4,689	4,716	4,743
28	4,770	4,798	4,825	4,853	4,881	4,908	4,936	4,964	4,992	5,020
29	5,048	5,076	5,105	5,133	5,161	5,190	5,218	5,247	5,276	5,305
30	5,333	5,362	5,391	5,420	5,450	5,479	5,508	5,537	5,567	5,596
31	5,626	5,656	5,685	5,715	5,745	5,775	5,805	5,835	5,865	5,896
32	5,926	5,956	5,987	6,017	6,048	6,079	6,110	6,140	6,171	6,202
33	6,233	6,265	6,296	6,327	6,358	6,390	6,421	6,453	6,485	6,516
34	6,548	6,580	6,612	6,644	6,676	6,708	6,741	6,773	6,805	6,838
35	6,870	6,903	6,936	6,969	7,001	7,034	7,067	7,100	7,134	7,167
36	7,200	7,233	7,267	7,300	7,334	7,368	7,401	7,435	7,469	7,503
37	7,537	7,571	7,605	7,640	7,674	7,708	7,743	7,777	7,812	7,847
38	7,881	7,916	7,951	7,986	8,021	8,057	8,092	8,127	8,162	8,198
39	8,233	8,269	8,305	8,340	8,376	8,412	8,448	8,484	8,520	8,556
40	8,592	8,629	8,665	8,703	8,738	8,775	8,812	8,849	8,885	8,929
41	8,959	8,996	9,034	9,071	9,108	9,145	9,183	9,220	9,258	9,296
42	9,333	9,371	9,409	9,447	9,485	9,523	9,561	9,600	9,638	9,676
43	9,715	9,753	9,792	9,831	9,870	9,908	9,947	9,986	10,025	10,065
44	10,104	10,143	10,182	10,222	10,261	10,301	10,341	10,380	10,420	10,460
45	10,500	10,540	10,580	10,620	10,660	10,701	10,741	10,782	10,822	10,863
46	10,904	10,945	10,985	11,026	11,067	11,108	11,150	11,191	11,232	11,273
47	11,315	11,356	11,398	11,440	11,481	11,523	11,565	11,607	11,649	11,691
48	11,733	11,776	11,818	11,860	11,903	11,945	11,988	12,031	12,074	12,115
49	12,159	12,201	12,244	12,288	12,331	12,374	12,417	12,462	12,505	12,549
50	12,593	12,636	12,680	12,724	12,768	12,812	12,856	12,900	12,945	12,989
51	13,033	13,078	13,122	13,167	13,212	13,257	13,301	13,346	13,391	13,436
52	13,482	13,527	13,572	13,617	13,663	13,708	13,754	13,800	13,845	13,891
53	13,937	13,983	14,029	14,075	14,121	14,168	14,214	14,260	14,307	14,353
54	14,400	14,447	14,494	14,540	14,587	14,634	14,681	14,728	14,776	14,823
55	14,870	14,918	14,965	15,013	15,061	15,108	15,156	15,204	15,252	15,300
56	15,348	15,396	15,445	15,493	15,541	15,590	15,638	15,687	15,736	15,785
57	15,833	15,882	15,931	15,980	16,030	16,079	16,128	16,177	16,227	16,276
58	16,326	16,376	16,425	16,475	16,525	16,575	16,625	16,675	16,725	16,776
59	16,802	16,876	16,926	16,977	17,028	17,079	17,130	17,180	17,231	17,282
60	17,333	17,384	17,436	17,487	17,538	17,590	17,641	17,693	17,745	17,796

TABLE No. X.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 25 FEET.

Feet.	0	1	2	3	4	5	6	7	8	9
	c. yds.									
0	0	9	19	28	38	47	57	66	76	86
1	96	106	116	127	137	147	158	168	179	189
2	200	211	222	233	244	255	266	277	288	300
3	311	323	334	346	358	369	381	393	405	417
4	430	442	454	467	479	492	504	517	530	543
5	556	569	582	595	608	621	635	648	662	675
6	689	703	716	730	744	758	772	787	801	815
7	830	844	859	873	888	903	918	933	948	963
8	978	993	1,008	1,024	1,039	1,055	1,070	1,086	1,102	1,117
9	1,133	1,149	1,165	1,181	1,196	1,214	1,230	1,247	1,263	1,280
10	1,296	1,313	1,330	1,347	1,364	1,381	1,398	1,415	1,432	1,449
11	1,467	1,484	1,502	1,519	1,537	1,555	1,572	1,590	1,608	1,626
12	1,644	1,663	1,681	1,699	1,718	1,736	1,755	1,773	1,792	1,811
13	1,830	1,849	1,868	1,887	1,906	1,925	1,944	1,964	1,983	2,003
14	2,022	2,042	2,062	2,081	2,101	2,121	2,141	2,161	2,182	2,202
15	2,222	2,243	2,263	2,284	2,304	2,325	2,346	2,367	2,388	2,409
16	2,430	2,451	2,472	2,493	2,515	2,536	2,558	2,579	2,601	2,623
17	2,644	2,666	2,688	2,711	2,733	2,756	2,778	2,800	2,822	2,844
18	2,867	2,889	2,912	2,935	2,958	2,981	3,004	3,027	3,050	3,073
19	3,096	3,120	3,143	3,167	3,190	3,214	3,238	3,261	3,285	3,309
20	3,333	3,357	3,381	3,406	3,430	3,455	3,479	3,504	3,528	3,553
21	3,578	3,603	3,628	3,653	3,678	3,703	3,728	3,753	3,779	3,804
22	3,830	3,855	3,881	3,907	3,932	3,958	3,984	4,010	4,036	4,063
23	4,089	4,115	4,142	4,168	4,195	4,221	4,248	4,275	4,302	4,329
24	4,356	4,383	4,410	4,437	4,464	4,492	4,519	4,547	4,574	4,602
25	4,630	4,657	4,685	4,713	4,741	4,769	4,798	4,826	4,854	4,883
26	4,911	4,940	4,968	4,997	5,026	5,055	5,084	5,113	5,142	5,171
27	5,200	5,229	5,259	5,288	5,318	5,347	5,377	5,407	5,436	5,466
28	5,496	5,526	5,556	5,586	5,617	5,647	5,678	5,708	5,739	5,769
29	5,800	5,831	5,862	5,893	5,924	5,955	5,986	6,017	6,048	6,080
30	6,114	6,143	6,174	6,206	6,238	6,269	6,301	6,333	6,365	6,397
31	6,430	6,462	6,494	6,527	6,559	6,592	6,624	6,657	6,690	6,723
32	6,756	6,789	6,822	6,855	6,888	6,921	6,955	6,988	7,022	7,055
33	7,088	7,123	7,156	7,190	7,224	7,258	7,292	7,327	7,361	7,395
34	7,430	7,464	7,499	7,533	7,568	7,603	7,638	7,673	7,708	7,743
35	7,778	7,813	7,848	7,884	7,919	7,955	7,990	8,026	8,062	8,097
36	8,133	8,169	8,205	8,241	8,278	8,314	8,350	8,387	8,423	8,460
37	8,496	8,533	8,570	8,607	8,644	8,681	8,718	8,755	8,792	8,829
38	8,867	8,904	8,942	8,979	9,017	9,055	9,092	9,130	9,168	9,206
39	9,244	9,283	9,321	9,359	9,398	9,436	9,475	9,513	9,552	9,591
40	9,629	9,669	9,708	9,747	9,786	9,825	9,864	9,904	9,943	9,983
41	10,022	10,062	10,102	10,141	10,181	10,221	10,261	10,301	10,342	10,382
42	10,422	10,463	10,503	10,544	10,584	10,625	10,666	10,707	10,748	10,788
43	10,830	10,871	10,912	10,953	10,995	11,036	11,078	11,119	11,161	11,203
44	11,244	11,286	11,328	11,370	11,412	11,455	11,497	11,539	11,582	11,624
45	11,667	11,709	11,752	11,795	11,837	11,880	11,923	11,966	12,010	12,053
46	12,096	12,140	12,183	12,227	12,270	12,314	12,358	12,401	12,445	12,489
47	12,533	12,577	12,622	12,666	12,710	12,755	12,799	12,844	12,888	12,933
48	12,978	13,023	13,068	13,113	13,158	13,203	13,248	13,293	13,339	13,384
49	13,430	13,475	13,521	13,567	13,612	13,658	13,704	13,750	13,796	13,843
50	13,889	13,935	13,982	14,028	14,075	14,121	14,168	14,215	14,262	14,309
51	14,356	14,403	14,450	14,497	14,544	14,592	14,639	14,687	14,734	14,782
52	14,830	14,877	14,925	14,973	15,021	15,069	15,118	15,166	15,214	15,263
53	15,311	15,360	15,408	15,457	15,506	15,555	15,604	15,653	15,702	15,751
54	15,800	15,849	15,899	15,948	15,998	16,047	16,097	16,147	16,196	16,246
55	16,296	16,346	16,396	16,447	16,497	16,547	16,598	16,648	16,699	16,749
56	16,800	16,851	16,902	16,953	17,004	17,055	17,106	17,157	17,208	17,260
57	17,311	17,363	17,414	17,466	17,518	17,569	17,621	17,673	17,725	17,777
58	17,830	17,882	17,934	17,987	18,039	18,092	18,144	18,197	18,250	18,303
59	18,356	18,409	18,462	18,515	18,568	18,621	18,675	18,728	18,782	18,836
60	18,889	18,943	18,996	19,050	19,104	19,158	19,212	19,267	19,321	19,375

TABLE No. XI.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 28 FEET.

Feet.	0	1	2	3	4	5	6	7	8	9
	e. yds.									
0	0	10	21	31	42	53	63	74	85	96
1	107	119	130	141	152	164	175	187	199	210
2	222	234	246	258	270	282	295	306	319	332
3	344	357	370	383	395	408	421	434	448	461
4	474	487	501	514	528	542	555	569	583	597
5	611	625	639	654	668	682	697	711	726	741
6	756	770	785	800	815	831	846	861	876	892
7	907	923	939	954	970	986	1,002	1,018	1,034	1,050
8	1,067	1,083	1,099	1,116	1,132	1,149	1,166	1,183	1,199	1,216
9	1,233	1,250	1,268	1,285	1,302	1,319	1,337	1,354	1,372	1,390
10	1,407	1,425	1,443	1,461	1,479	1,497	1,515	1,534	1,552	1,570
11	1,589	1,607	1,626	1,645	1,664	1,682	1,701	1,720	1,739	1,759
12	1,778	1,797	1,816	1,836	1,855	1,875	1,895	1,914	1,934	1,954
13	1,974	1,994	2,014	2,034	2,055	2,075	2,095	2,116	2,136	2,157
14	2,178	2,199	2,219	2,240	2,261	2,282	2,304	2,325	2,346	2,367
15	2,389	2,410	2,432	2,454	2,475	2,497	2,519	2,542	2,563	2,585
16	2,607	2,630	2,652	2,674	2,697	2,719	2,742	2,765	2,788	2,810
17	2,833	2,856	2,879	2,903	2,926	2,949	2,972	2,996	3,019	3,043
18	3,067	3,090	3,114	3,138	3,167	3,186	3,210	3,234	3,259	3,283
19	3,307	3,332	3,356	3,381	3,406	3,431	3,455	3,480	3,505	3,530
20	3,556	3,581	3,606	3,631	3,657	3,682	3,708	3,734	3,759	3,785
21	3,811	3,837	3,863	3,889	3,915	3,942	3,968	3,994	4,021	4,047
22	4,074	4,101	4,128	4,154	4,181	4,208	4,235	4,263	4,290	4,317
23	4,344	4,372	4,399	4,427	4,455	4,482	4,510	4,538	4,566	4,594
24	4,622	4,650	4,679	4,707	4,735	4,764	4,792	4,821	4,850	4,879
25	4,907	4,935	4,965	4,994	5,024	5,053	5,082	5,111	5,141	5,170
26	5,200	5,230	5,260	5,289	5,319	5,349	5,379	5,409	5,439	5,470
27	5,500	5,530	5,561	5,591	5,622	5,653	5,684	5,714	5,745	5,776
28	5,807	5,839	5,870	5,901	5,932	5,964	5,995	6,027	6,059	6,090
29	6,122	6,154	6,186	6,218	6,250	6,282	6,315	6,347	6,379	6,412
30	6,444	6,477	6,510	6,542	6,575	6,608	6,641	6,674	6,707	6,741
31	6,774	6,807	6,841	6,874	6,908	6,942	6,975	7,009	7,043	7,077
32	7,111	7,145	7,179	7,214	7,248	7,282	7,317	7,351	7,386	7,421
33	7,456	7,490	7,525	7,560	7,595	7,631	7,666	7,701	7,736	7,772
34	7,807	7,843	7,879	7,914	7,950	7,986	8,022	8,058	8,094	8,130
35	8,167	8,203	8,239	8,276	8,312	8,349	8,386	8,423	8,459	8,496
36	8,533	8,570	8,608	8,645	8,682	8,719	8,757	8,794	8,832	8,870
37	8,907	8,945	8,983	9,021	9,059	9,097	9,135	9,173	9,212	9,250
38	9,289	9,327	9,366	9,405	9,444	9,482	9,521	9,560	9,599	9,639
39	9,678	9,717	9,756	9,796	9,835	9,875	9,915	9,954	9,994	10,034
40	10,074	10,114	10,154	10,194	10,235	10,275	10,315	10,356	10,396	10,437
41	10,478	10,519	10,559	10,600	10,641	10,682	10,724	10,765	10,806	10,847
42	10,889	10,930	10,972	11,014	11,055	11,097	11,139	11,181	11,223	11,265
43	11,307	11,350	11,392	11,434	11,477	11,519	11,562	11,605	11,648	11,690
44	11,733	11,776	11,819	11,863	11,906	11,949	11,992	12,036	12,079	12,123
45	12,167	12,210	12,254	12,298	12,342	12,386	12,430	12,474	12,519	12,563
46	12,607	12,652	12,696	12,741	12,786	12,831	12,875	12,920	12,965	13,010
47	13,056	13,101	13,146	13,191	13,237	13,282	13,328	13,374	13,419	13,465
48	13,511	13,557	13,603	13,649	13,695	13,742	13,788	13,834	13,881	13,927
49	13,974	14,021	14,068	14,114	14,161	14,208	14,255	14,303	14,350	14,397
50	14,444	14,492	14,539	14,587	14,635	14,682	14,730	14,778	14,826	14,875
51	14,922	14,970	15,019	15,067	15,115	15,164	15,212	15,261	15,310	15,359
52	15,407	15,456	15,505	15,554	15,604	15,653	15,702	15,751	15,801	15,850
53	15,900	15,950	15,999	16,049	16,099	16,149	16,199	16,249	16,299	16,350
54	16,400	16,450	16,501	16,551	16,602	16,653	16,704	16,754	16,805	16,856
55	16,907	16,959	17,010	17,061	17,112	17,164	17,215	17,267	17,319	17,370
56	17,422	17,474	17,526	17,578	17,630	17,682	17,735	17,787	17,839	17,892
57	17,944	17,997	18,050	18,103	18,155	18,208	18,261	18,314	18,368	18,421
58	18,474	18,527	18,581	18,634	18,688	18,742	18,795	18,849	18,903	18,957
59	19,011	19,065	19,119	19,174	19,228	19,282	19,337	19,391	19,446	19,501
60	19,556	19,610	19,665	19,720	19,775	19,831	19,886	19,941	19,996	20,052

TABLE No. XII.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 30 FEET.

Feet	0	1	2	3	4	5	6	7	8	9
	e. yds.									
0	0	11	22	34	45	56	68	79	91	103
1	115	127	138	151	163	175	187	199	212	224
2	237	250	262	275	288	301	314	327	340	353
3	367	380	393	407	421	434	448	462	476	490
4	504	518	532	546	561	575	589	604	619	633
5	648	663	678	693	708	723	738	754	769	784
6	800	816	831	847	863	879	895	911	927	943
7	959	976	992	1,008	1,025	1,042	1,058	1,075	1,092	1,109
8	1,126	1,143	1,160	1,177	1,195	1,212	1,229	1,247	1,265	1,282
9	1,300	1,318	1,336	1,354	1,372	1,390	1,408	1,426	1,445	1,463
10	1,481	1,500	1,519	1,537	1,556	1,575	1,594	1,613	1,632	1,651
11	1,670	1,690	1,709	1,729	1,748	1,768	1,787	1,807	1,827	1,847
12	1,867	1,887	1,907	1,927	1,947	1,968	1,988	2,008	2,029	2,050
13	2,070	2,091	2,112	2,133	2,154	2,175	2,196	2,217	2,239	2,260
14	2,281	2,303	2,325	2,346	2,368	2,390	2,412	2,434	2,456	2,478
15	2,500	2,522	2,544	2,567	2,589	2,612	2,634	2,657	2,680	2,703
16	2,726	2,749	2,772	2,795	2,818	2,842	2,865	2,888	2,912	2,936
17	2,959	2,983	3,007	3,031	3,054	3,079	3,103	3,127	3,151	3,175
18	3,200	3,224	3,249	3,273	3,298	3,323	3,348	3,373	3,398	3,423
19	3,448	3,473	3,498	3,524	3,549	3,575	3,604	3,626	3,652	3,678
20	3,703	3,729	3,756	3,782	3,808	3,834	3,860	3,887	3,913	3,940
21	3,966	3,993	4,020	4,047	4,074	4,101	4,128	4,155	4,182	4,209
22	4,237	4,264	4,292	4,319	4,347	4,375	4,403	4,431	4,458	4,486
23	4,515	4,543	4,571	4,599	4,628	4,656	4,685	4,713	4,742	4,771
24	4,800	4,829	4,858	4,887	4,916	4,945	4,974	5,004	5,033	5,063
25	5,092	5,122	5,152	5,182	5,212	5,242	5,272	5,302	5,332	5,362
26	5,392	5,423	5,453	5,484	5,514	5,545	5,576	5,607	5,638	5,669
27	5,700	5,731	5,762	5,793	5,825	5,856	5,888	5,919	5,951	5,983
28	6,015	6,047	6,079	6,111	6,143	6,175	6,207	6,239	6,272	6,304
29	6,337	6,369	6,402	6,435	6,468	6,500	6,534	6,567	6,600	6,633
30	6,666	6,700	6,733	6,767	6,801	6,834	6,868	6,902	6,936	6,970
31	7,004	7,038	7,072	7,106	7,141	7,175	7,209	7,244	7,279	7,313
32	7,348	7,383	7,418	7,453	7,488	7,523	7,558	7,594	7,629	7,664
33	7,700	7,736	7,771	7,807	7,843	7,879	7,915	7,951	7,987	8,023
34	8,059	8,096	8,132	8,168	8,205	8,242	8,278	8,315	8,352	8,389
35	8,426	8,463	8,500	8,537	8,575	8,612	8,649	8,687	8,725	8,762
36	8,800	8,838	8,876	8,914	8,951	8,990	9,028	9,066	9,105	9,143
37	9,181	9,220	9,259	9,279	9,336	9,375	9,414	9,453	9,492	9,531
38	9,570	9,610	9,649	9,688	9,728	9,768	9,807	9,847	9,887	9,927
39	9,967	10,007	10,047	10,087	10,127	10,168	10,208	10,248	10,289	10,330
40	10,370	10,411	10,452	10,493	10,534	10,575	10,616	10,657	10,699	10,740
41	10,781	10,823	10,865	10,906	10,948	10,990	11,032	11,074	11,116	11,158
42	11,200	11,242	11,285	11,327	11,369	11,412	11,455	11,497	11,540	11,583
43	11,626	11,669	11,712	11,755	11,798	11,842	11,885	11,928	11,972	12,016
44	12,059	12,103	12,147	12,191	12,235	12,279	12,323	12,367	12,411	12,456
45	12,500	12,544	12,589	12,634	12,678	12,723	12,768	12,813	12,858	12,903
46	12,948	12,993	13,039	13,084	13,129	13,275	13,321	13,466	13,512	13,558
47	13,404	13,450	13,496	13,542	13,588	13,634	13,681	13,727	13,773	13,820
48	13,667	13,913	13,960	14,007	14,054	14,101	14,148	14,195	14,242	14,290
49	14,371	14,384	14,432	14,480	14,527	14,575	14,623	14,671	14,719	14,767
50	14,815	14,863	14,912	14,960	15,008	15,056	15,105	15,154	15,202	15,251
51	15,300	15,349	15,398	15,447	15,496	15,545	15,595	15,644	15,693	15,743
52	15,793	15,842	15,892	15,942	15,992	16,041	16,092	16,142	16,192	16,242
53	16,293	16,343	16,393	16,444	16,495	16,545	16,596	16,647	16,698	16,749
54	16,800	16,851	16,902	16,954	17,005	17,056	17,108	17,160	17,211	17,263
55	17,315	17,367	17,419	17,471	17,523	17,575	17,627	17,680	17,732	17,785
56	17,837	17,890	17,942	17,995	18,048	18,101	18,154	18,207	18,260	18,313
57	18,367	18,420	18,473	18,527	18,581	18,634	18,688	18,742	18,796	18,850
58	18,904	18,958	19,012	19,066	19,121	19,175	19,230	19,284	19,339	19,393
59	19,448	19,503	19,558	19,613	19,678	19,723	19,778	19,834	19,889	19,944
60	20,000	20,056	20,111	20,167	20,223	20,279	20,335	20,391	20,447	20,503

TABLE No. XIII.

SLOPE 1 TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 34 FEET.

Feet	0 c. yds.	1 c. yds.	2 c. yds.	3 c. yds.	4 c. yds.	5 c. yds.	6 c. yds.	7 c. yds.	8 c. yds.	9 c. yds.
0	0	13	25	38	51	64	77	90	103	116
1	130	143	156	170	184	197	211	225	239	253
2	267	284	295	309	324	338	352	367	382	396
3	411	426	441	456	471	486	501	517	532	547
4	573	589	604	620	636	652	668	684	700	706
5	722	739	755	771	788	805	821	838	855	872
6	889	906	923	940	958	975	992	1,010	1,028	1,045
7	1,063	1,081	1,099	1,117	1,135	1,153	1,171	1,189	1,208	1,226
8	1,244	1,263	1,282	1,300	1,319	1,338	1,357	1,376	1,395	1,414
9	1,433	1,453	1,472	1,491	1,511	1,531	1,550	1,570	1,590	1,610
10	1,630	1,650	1,670	1,690	1,710	1,731	1,751	1,771	1,792	1,813
11	1,833	1,854	1,875	1,896	1,917	1,938	1,959	1,980	2,002	2,023
12	2,044	2,066	2,088	2,109	2,131	2,153	2,175	2,197	2,219	2,241
13	2,263	2,285	2,306	2,330	2,352	2,375	2,398	2,420	2,443	2,466
14	2,489	2,512	2,535	2,558	2,581	2,605	2,628	2,651	2,675	2,699
15	2,722	2,746	2,770	2,794	2,818	2,842	2,866	2,890	2,914	2,939
16	2,963	2,987	3,012	3,037	3,061	3,086	3,111	3,136	3,161	3,186
17	3,211	3,236	3,262	3,287	3,312	3,338	3,364	3,389	3,415	3,441
18	3,467	3,493	3,519	3,545	3,571	3,597	3,624	3,650	3,676	3,703
19	3,730	3,756	3,783	3,810	3,837	3,864	3,891	3,918	3,945	3,973
20	4,000	4,027	4,055	4,083	4,110	4,138	4,166	4,194	4,222	4,250
21	4,298	4,306	4,334	4,363	4,391	4,319	4,348	4,376	4,506	4,534
22	4,563	4,592	4,621	4,650	4,679	4,708	4,738	4,767	4,796	4,826
23	4,856	4,885	4,915	4,945	4,975	5,005	5,035	5,065	5,095	5,125
24	5,156	5,186	5,216	5,247	5,278	5,308	5,339	5,370	5,401	5,432
25	5,463	5,494	5,525	5,557	5,588	5,619	5,651	5,683	5,714	5,746
26	5,778	5,810	5,842	5,874	5,906	5,938	5,970	6,003	6,035	6,067
27	6,100	6,133	6,165	6,198	6,231	6,264	6,297	6,330	6,363	6,396
28	6,430	6,463	6,496	6,530	6,564	6,597	6,631	6,665	6,699	6,733
29	6,767	6,801	6,835	6,869	6,904	6,938	6,972	7,007	7,042	7,076
30	7,111	7,146	7,181	7,216	7,251	7,286	7,321	7,357	7,392	7,427
31	7,463	7,499	7,534	7,570	7,606	7,642	7,678	7,714	7,750	7,786
32	7,922	7,859	7,895	7,931	7,968	8,005	8,041	8,078	8,115	8,152
33	8,189	8,226	8,263	8,300	8,338	8,375	8,412	8,450	8,488	8,525
34	8,563	8,601	8,639	8,677	8,715	8,753	8,791	8,829	8,868	8,906
35	8,944	8,983	9,022	9,060	9,099	9,138	9,177	9,216	9,255	9,294
36	9,333	9,373	9,412	9,451	9,491	9,531	9,570	9,610	9,650	9,690
37	9,730	9,770	9,810	9,850	9,890	9,931	9,971	10,011	10,052	10,093
38	10,133	10,174	10,215	10,256	10,297	10,338	10,379	10,420	10,462	10,503
39	10,544	10,586	10,628	10,669	10,711	10,753	10,795	10,837	10,879	10,921
40	10,963	11,005	11,048	11,090	11,132	11,175	11,218	11,260	11,303	11,346
41	11,389	11,432	11,475	11,518	11,561	11,605	11,648	11,691	11,735	11,779
42	11,822	11,866	11,910	11,954	11,998	12,042	12,086	12,130	12,174	12,219
43	12,263	12,307	12,352	12,397	12,441	12,486	12,531	12,576	12,621	12,666
44	12,711	12,756	12,802	12,847	12,892	12,938	12,984	13,029	13,075	13,121
45	13,167	13,213	13,259	13,305	13,351	13,397	13,444	13,490	13,536	13,583
46	13,630	13,676	13,723	13,770	13,817	13,864	13,911	13,958	14,005	14,053
47	14,100	14,147	14,195	14,243	14,290	14,338	14,386	14,434	14,482	14,530
48	14,578	14,626	14,674	14,723	14,771	14,819	14,868	14,917	14,965	15,014
49	15,063	15,112	15,161	15,210	15,259	15,308	15,358	15,407	15,456	15,506
50	15,556	15,605	15,655	15,705	15,756	15,805	15,855	15,905	15,955	16,005
51	16,056	16,106	16,156	16,207	16,258	16,308	16,359	16,410	16,461	16,512
52	16,563	16,614	16,665	16,717	16,768	16,819	16,871	16,923	16,974	17,026
53	17,078	17,130	17,189	17,234	17,286	17,338	17,390	17,443	17,495	17,547
54	17,600	17,653	17,705	17,758	17,811	17,864	17,917	17,970	18,023	18,076
55	18,130	18,183	18,236	18,290	18,344	18,397	18,451	18,105	18,559	18,613
56	18,667	18,721	18,775	18,829	18,884	18,938	18,992	19,047	18,102	19,156
57	19,211	19,266	19,321	19,376	19,431	19,486	19,541	19,597	19,652	19,707
58	19,763	19,819	19,874	19,930	19,986	20,042	20,098	20,154	20,210	20,266
59	20,322	20,379	20,435	20,491	20,548	20,605	20,661	20,718	20,775	20,832
60	20,889	20,946	21,003	21,060	21,118	21,175	21,232	21,290	21,348	21,504

TABLE No. XIV.  
SLOPE 1 TO 1.  
CORRECTION FOR DIFFERENCES OF DEPTHS.

Feet.	0 c. yds.	1 c. yds.	2 c. yds.	3 c. yds.	4 c. yds.	5 c. yds.	6 c. yds.	7 c. yds.	8 c. yds.	9 c. yds.
1	0	0	0	1	1	1	1	1	1	1
2	1	1	1	2	2	2	2	2	2	3
3	3	3	3	3	4	4	4	4	4	5
4	5	5	5	6	6	6	7	7	7	7
5	8	8	8	9	9	9	10	10	10	11
6	11	11	12	12	13	13	13	14	14	15
7	15	16	16	16	17	17	18	18	19	19
8	20	20	21	21	22	22	23	23	24	24
9	25	26	26	27	27	28	28	29	30	30
10	31	31	32	33	33	34	35	35	36	37
11	37	38	39	39	40	41	42	42	43	44
12	44	45	46	47	47	48	49	50	50	51
13	52	53	54	55	55	56	57	58	59	60
14	60	61	62	63	64	65	66	67	68	69
15	69	70	71	72	73	74	75	76	77	78
16	79	80	81	82	83	84	85	86	87	88
17	89	90	91	92	93	95	96	97	98	99
18	100	101	102	103	104	106	107	108	109	110
19	111	113	114	115	116	117	119	120	121	122
20	123	125	126	127	128	130	131	132	134	135
21	136	137	139	140	141	143	144	145	147	148
22	149	151	152	153	155	156	158	159	160	162
23	163	165	166	168	169	170	172	173	175	176
24	178	179	181	182	184	185	187	188	190	191
25	193	194	196	198	199	201	202	204	205	207
26	209	210	212	213	215	217	218	220	222	223
27	225	227	228	230	232	233	235	237	239	240
28	242	244	245	247	249	251	252	254	256	258
29	260	261	263	265	267	269	270	272	274	276
30	278	280	281	283	285	287	289	291	293	295
31	297	298	300	302	304	306	308	310	312	314
32	316	318	320	322	324	326	328	330	332	334
33	336	338	340	342	344	346	348	350	353	355
34	357	359	361	363	365	367	369	372	374	376
35	378	380	382	385	387	389	391	393	396	398
36	400	402	404	407	409	411	413	416	418	420
37	423	425	427	429	432	434	436	439	441	443
38	446	448	450	453	455	457	460	462	465	467
39	469	472	474	477	479	482	484	486	489	491
40	494	496	499	501	504	506	509	511	514	516
41	519	521	524	526	529	531	534	537	539	541
42	544	547	550	552	555	558	560	563	565	568
43	571	573	576	579	581	584	587	589	592	595
44	598	600	603	606	608	611	614	617	619	622
45	625	628	631	633	636	639	642	645	647	650

TABLE No. XV.

SLOPE  $1\frac{1}{2}$  TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 15 FEET.

Feet	0 c. yds.	1 c. yds.	2 c. yds.	3 c. yds.	4 c. yds.	5 c. yds.	6 c. yds.	7 c. yds.	8 c. yds.	9 c. yds.
0	0	6	11	17	23	29	35	42	48	54
1	61	68	75	82	89	96	103	110	118	126
2	133	141	149	157	165	174	182	190	199	208
3	217	225	234	243	252	261	271	281	290	301
4	311	321	331	342	352	362	373	384	395	406
5	417	428	439	450	462	474	485	497	509	521
6	533	546	558	570	583	596	609	622	635	648
7	661	674	688	702	715	729	743	757	771	786
8	800	814	829	844	859	874	889	904	919	934
9	949	966	981	997	1,013	1,029	1,045	1,062	1,078	1,095
10	1,110	1,128	1,145	1,162	1,179	1,196	1,213	1,230	1,248	1,266
11	1,283	1,301	1,319	1,337	1,355	1,374	1,392	1,410	1,429	1,448
12	1,467	1,486	1,505	1,524	1,543	1,562	1,582	1,601	1,621	1,641
13	1,661	1,681	1,701	1,722	1,742	1,762	1,783	1,804	1,825	1,846
14	1,867	1,888	1,909	1,930	1,952	1,974	1,995	2,017	2,039	2,061
15	2,083	2,106	2,128	2,150	2,173	2,196	2,219	2,242	2,265	2,288
16	2,311	2,334	2,358	2,382	2,405	2,429	2,453	2,477	2,501	2,526
17	2,550	2,574	2,599	2,624	2,649	2,674	2,699	2,724	2,749	2,774
18	2,800	2,826	2,851	2,877	2,903	2,929	2,955	2,982	3,008	3,034
19	3,061	3,088	3,105	3,132	3,169	3,196	3,223	3,250	3,278	3,306
20	3,333	3,361	3,389	3,417	3,445	3,474	3,502	3,530	3,559	3,588
21	3,617	3,646	3,675	3,704	3,733	3,763	3,793	3,822	3,852	3,882
22	3,911	3,941	3,971	4,002	4,032	4,062	4,093	4,124	4,155	4,186
23	4,217	4,248	4,279	4,310	4,342	4,374	4,405	4,437	4,469	4,501
24	4,533	4,566	4,598	4,630	4,663	4,696	4,729	4,762	4,795	4,828
25	4,861	4,894	4,928	4,962	4,995	5,029	5,063	5,097	5,131	5,166
26	5,200	5,234	5,269	5,304	5,339	5,374	5,409	5,444	5,479	5,514
27	5,550	5,586	5,621	5,657	5,693	5,729	5,765	5,802	5,838	5,874
28	5,911	5,948	5,985	6,022	6,059	6,096	6,133	6,170	6,028	6,246
29	6,283	6,321	6,359	6,397	6,435	6,474	6,512	6,550	6,589	6,628
30	6,667	6,706	6,745	6,784	6,823	6,862	6,902	6,942	6,981	7,021
31	7,061	7,101	7,141	7,182	7,222	7,262	7,303	7,344	7,385	7,426
32	7,467	7,508	7,549	7,590	7,632	7,674	7,715	7,757	7,799	7,841
33	7,883	7,926	7,968	8,010	8,053	8,096	8,139	8,182	8,225	8,268
34	8,311	8,354	8,398	8,442	8,485	8,529	8,573	8,617	8,661	8,706
35	8,750	8,794	8,839	8,884	8,929	8,974	9,019	9,064	9,109	9,154
36	9,200	9,246	9,291	9,337	9,383	9,429	9,475	9,522	9,568	9,614
37	9,661	9,708	9,755	9,802	9,849	9,896	9,943	9,990	10,038	10,086
38	10,133	10,181	10,229	10,277	10,325	10,374	10,422	10,470	10,519	10,568
39	10,617	10,666	10,715	10,764	10,813	10,862	10,912	10,962	11,011	11,061
40	11,111	11,161	11,212	11,262	11,312	11,362	11,413	11,464	11,515	11,565
41	11,616	11,668	11,719	11,770	11,822	11,874	11,925	11,977	12,029	12,081
42	12,132	12,186	12,238	12,290	12,343	12,396	12,449	11,502	12,555	12,608
43	12,661	12,714	12,768	12,822	12,875	12,929	12,983	13,037	13,091	13,146
44	13,200	13,254	13,309	13,364	13,418	13,473	13,528	13,583	13,638	13,693
45	13,750	13,806	13,961	13,917	13,973	14,029	14,085	14,142	14,198	14,254
46	14,311	14,368	14,425	14,482	14,539	14,576	14,653	14,710	14,768	14,826
47	14,883	14,941	14,999	15,057	15,115	15,174	15,232	15,090	15,349	15,408
48	15,467	15,526	15,585	15,644	15,703	15,762	15,822	15,882	15,941	16,001
49	16,061	16,121	16,181	16,242	16,302	16,362	16,423	16,484	16,545	16,606
50	16,667	16,728	16,788	16,849	16,911	16,973	17,034	17,096	17,158	17,220
51	17,283	17,346	17,408	17,470	17,533	17,596	17,659	17,722	17,785	17,848
52	17,911	17,975	18,038	18,102	18,165	18,229	18,293	18,357	18,421	18,486
53	18,550	18,614	18,679	18,744	18,809	18,874	18,939	19,004	19,069	19,134
54	19,200	19,266	19,331	19,397	19,463	19,529	19,595	19,662	19,728	19,794
55	19,861	19,928	19,995	20,062	20,129	20,196	20,263	20,330	20,408	20,476
56	20,533	20,601	20,669	20,737	20,805	20,874	20,942	21,011	21,079	21,148
57	21,217	21,286	21,355	21,424	21,493	21,562	21,632	21,702	21,771	21,841
58	21,911	21,981	22,051	22,122	22,192	22,262	22,333	22,404	22,475	22,546
59	22,617	22,688	22,759	22,830	22,902	22,974	23,045	23,117	23,189	23,261
60	23,333	23,406	23,478	23,550	23,623	23,696	23,769	23,842	23,915	23,988

TABLE No. XVI.

SLOPE  $1\frac{1}{2}$  TO 1.  
CONTENT FOR AVERAGE DEPTHS, BASE 18 FEET.

Feet	0	1	2	3	4	5	6	7	8	9
	e. yds.									
0	0	7	14	20	28	35	42	49	57	65
1	72	80	88	96	104	112	121	129	138	147
2	156	164	174	183	192	201	211	220	230	240
3	250	260	270	280	291	301	312	323	334	344
4	356	367	378	389	401	412	424	436	448	460
5	472	484	497	509	522	535	548	560	574	587
6	600	613	627	640	654	668	682	696	710	724
7	739	753	768	782	797	812	828	843	858	873
8	889	904	920	936	952	968	984	1,000	1,017	1,033
9	1,050	1,067	1,084	1,100	1,118	1,135	1,152	1,169	1,187	1,204
10	1,222	1,240	1,258	1,276	1,294	1,312	1,331	1,349	1,368	1,387
11	1,406	1,424	1,444	1,463	1,482	1,501	1,521	1,540	1,560	1,580
12	1,600	1,620	1,640	1,660	1,681	1,701	1,722	1,743	1,764	1,784
13	1,806	1,827	1,848	1,869	1,891	1,912	1,934	1,956	1,978	2,000
14	2,022	2,044	2,067	2,089	2,112	2,135	2,158	2,180	2,204	2,227
15	2,250	2,273	2,297	2,320	2,344	2,368	2,392	2,416	2,440	2,464
16	2,489	2,513	2,538	2,563	2,588	2,612	2,638	2,663	2,688	2,713
17	2,739	2,764	2,790	2,816	2,842	2,868	2,894	2,920	2,947	2,973
18	3,000	3,027	3,054	3,080	3,108	3,135	3,162	3,189	3,217	3,244
19	3,272	3,300	3,328	3,356	3,384	3,412	3,441	3,469	3,498	3,527
20	3,556	3,584	3,614	3,643	3,672	3,701	3,731	3,760	3,790	3,820
21	3,850	3,880	3,910	3,940	3,971	4,001	4,032	4,063	4,094	4,124
22	4,156	4,187	4,218	4,249	4,281	4,312	4,344	4,376	4,408	4,440
23	4,472	4,504	4,537	4,569	4,602	4,635	4,668	4,700	4,734	4,767
24	4,800	4,833	4,867	4,900	4,934	4,968	5,002	5,036	5,070	5,104
25	5,139	5,173	5,208	5,243	5,278	5,312	5,348	5,383	5,418	5,453
26	5,489	5,524	5,560	5,596	5,632	5,668	5,704	5,740	5,777	5,813
27	5,850	5,887	5,924	5,960	5,998	6,035	6,072	6,109	6,147	6,184
28	6,222	6,260	6,298	6,336	6,374	6,412	6,451	6,489	6,528	6,567
29	6,606	6,644	6,684	6,723	6,762	6,801	6,841	6,880	6,920	6,960
30	7,000	7,040	7,080	7,120	7,161	7,201	7,242	7,283	7,324	7,364
31	7,406	7,447	7,488	7,529	7,571	7,612	7,654	7,696	7,738	7,780
32	7,822	7,864	7,907	7,949	7,992	8,035	8,078	8,120	8,164	8,207
33	8,250	8,293	8,337	8,380	8,424	8,468	8,512	8,556	8,600	8,644
34	8,689	8,733	8,778	8,823	8,868	8,912	8,958	9,003	9,048	9,093
35	9,139	9,184	9,230	9,276	9,322	9,368	9,414	9,460	9,507	9,553
36	9,600	9,647	9,694	9,740	9,788	9,835	9,882	9,929	9,977	10,024
37	10,072	10,120	10,168	10,216	10,264	10,312	10,361	10,409	10,458	10,507
38	10,556	10,604	10,654	10,703	10,752	10,801	10,851	10,900	10,950	11,000
39	11,050	11,100	11,150	11,200	11,251	11,301	11,352	11,403	11,454	11,504
40	11,556	11,607	11,658	11,709	11,761	11,812	11,864	11,916	11,968	12,020
41	12,072	12,124	12,177	12,229	12,282	12,335	12,388	12,440	12,493	12,547
42	12,600	12,653	12,707	12,760	12,814	12,868	12,922	12,976	13,030	13,084
43	13,139	13,193	13,248	13,303	13,358	13,412	13,468	13,523	13,578	13,633
44	13,689	13,744	13,800	13,856	13,912	13,968	14,024	14,080	14,137	14,193
45	14,250	14,307	14,364	14,420	14,478	14,535	14,592	14,649	14,707	14,764
46	14,822	14,880	14,938	14,996	15,054	15,102	15,161	15,229	15,288	15,347
47	15,406	15,464	15,524	15,583	15,642	15,701	15,761	15,820	15,880	15,940
48	16,000	16,060	16,120	16,180	16,241	16,301	16,362	16,423	16,484	16,544
49	16,606	16,667	16,728	16,789	16,851	16,912	16,974	17,036	17,098	17,160
50	17,222	17,281	17,347	17,409	17,472	17,535	17,598	17,660	17,724	17,787
51	17,850	17,913	17,977	18,040	18,104	18,168	18,232	18,296	18,360	18,424
52	18,489	18,553	18,618	18,683	18,748	18,812	18,878	18,943	19,008	19,073
53	19,139	19,204	19,270	19,336	19,402	19,468	19,534	19,600	19,667	19,733
54	19,800	19,867	19,934	20,000	20,068	20,135	20,202	20,269	20,337	20,404
55	20,472	20,540	20,608	20,676	20,744	20,812	20,881	20,949	21,018	21,087
56	21,156	21,224	21,294	21,363	21,432	21,501	21,571	21,640	21,710	21,780
57	21,850	21,920	21,990	22,060	22,131	22,201	22,272	22,343	22,414	22,484
58	22,556	22,627	22,698	22,769	22,841	22,912	22,984	23,056	23,128	23,200
59	23,272	23,344	23,417	23,489	23,562	23,635	23,708	23,780	23,854	23,927
60	24,000	24,073	24,147	24,220	24,294	24,368	24,442	24,516	24,590	24,664

TABLE No. XVII.

SLOPE  $1\frac{1}{2}$  TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 25 FEET.

Feet	0 c. yds.	1 c. yds.	2 c. yds.	3 c. yds.	4 c. yds.	5 c. yds.	6 c. yds.	7 c. yds.	8 c. yds.	9 c. yds.
0	0	9	19	28	38	48	58	68	78	88
1	98	109	119	130	141	151	162	173	185	199
2	207	219	231	242	254	266	278	290	303	315
3	328	340	353	366	379	392	405	419	432	446
4	459	473	487	501	515	529	543	558	572	587
5	602	617	632	647	662	677	693	708	724	740
6	756	772	788	804	820	837	853	870	887	903
7	920	937	955	972	989	1,007	1,025	1,042	1,060	1,078
8	1,096	1,114	1,133	1,151	1,170	1,188	1,207	1,226	1,245	1,264
9	1,283	1,303	1,322	1,342	1,361	1,381	1,401	1,421	1,441	1,461
10	1,481	1,502	1,522	1,543	1,564	1,585	1,606	1,627	1,648	1,669
11	1,691	1,712	1,734	1,756	1,778	1,800	1,822	1,844	1,866	1,889
12	1,911	1,934	1,957	1,979	2,002	2,025	2,049	2,072	2,095	2,119
13	2,143	2,166	2,190	2,214	2,238	2,262	2,287	2,311	2,336	2,360
14	2,385	2,410	2,435	2,460	2,485	2,511	2,536	2,562	2,587	2,613
15	2,639	2,665	2,691	2,717	2,743	2,770	2,796	2,823	2,850	2,877
16	2,904	2,931	2,958	2,985	3,013	3,040	3,068	3,096	3,124	3,152
17	3,180	3,208	3,236	3,265	3,293	3,322	3,351	3,379	3,408	3,437
18	3,467	3,496	3,525	3,555	3,585	3,614	3,644	3,674	3,704	3,735
19	3,765	3,795	3,826	3,856	3,887	3,918	3,949	3,980	4,011	4,043
20	4,074	4,106	4,137	4,169	4,201	4,233	4,265	4,297	4,329	4,362
21	4,394	4,427	4,460	4,493	4,526	4,559	4,592	4,625	4,659	4,692
22	4,726	4,760	4,794	4,828	4,862	4,896	4,930	4,965	4,999	5,034
23	5,069	5,103	5,138	5,173	5,209	5,244	5,279	5,315	5,351	5,386
24	5,422	5,458	5,494	5,530	5,567	5,603	5,640	5,676	5,713	5,750
25	5,787	5,824	5,861	5,899	5,936	5,974	6,011	6,049	6,087	6,125
26	6,163	6,201	6,239	6,278	6,316	6,355	6,394	6,433	6,472	6,511
27	6,550	6,589	6,629	6,668	6,708	6,748	6,788	6,828	6,868	6,908
28	6,948	6,989	7,029	7,070	7,111	7,151	7,192	7,233	7,275	7,316
29	7,357	7,399	7,441	7,482	7,524	7,566	7,608	7,651	7,693	7,735
30	7,778	7,820	7,863	7,906	7,949	7,992	8,035	8,079	8,122	8,166
31	8,209	8,253	8,297	8,341	8,385	8,429	8,473	8,518	8,562	8,607
32	8,652	8,697	8,742	8,787	8,832	8,877	8,923	8,968	9,014	9,060
33	9,106	9,152	9,198	9,244	9,290	9,337	9,383	9,430	9,477	9,523
34	9,570	9,617	9,665	9,712	9,759	9,807	9,855	9,902	9,950	9,998
35	10,046	10,094	10,143	10,191	10,240	10,288	10,337	10,386	10,435	10,484
36	10,533	10,583	10,632	10,682	10,731	10,781	10,831	10,881	10,931	10,981
37	11,031	11,082	11,132	11,183	11,234	11,285	11,336	11,387	11,438	11,489
38	11,541	11,592	11,641	11,696	11,748	11,800	11,852	11,904	11,956	12,009
39	12,061	12,114	12,167	12,219	12,272	12,325	12,379	12,432	12,485	12,539
40	12,593	12,646	12,700	12,754	12,808	12,862	12,917	12,971	13,026	13,080
41	13,135	13,190	13,245	13,300	13,355	13,411	13,466	13,522	13,577	13,633
42	13,689	13,745	13,801	13,857	13,913	13,970	14,026	14,083	14,140	14,197
43	14,254	14,311	14,368	14,425	14,483	14,540	14,598	14,656	14,714	14,772
44	14,830	14,888	14,946	15,005	15,063	15,122	15,181	15,239	15,298	15,357
45	15,417	15,476	15,535	15,595	15,655	15,714	15,774	15,834	15,894	15,954
46	16,015	16,075	16,136	16,196	16,257	16,318	16,379	16,440	16,501	16,563
47	16,624	16,686	16,747	16,809	16,871	16,933	16,995	17,057	17,119	17,182
48	17,244	17,307	17,370	17,433	17,496	17,559	17,622	17,685	17,749	17,812
49	17,876	17,940	18,004	18,068	18,132	18,196	18,260	18,325	18,389	18,454
50	18,519	18,583	18,648	18,713	18,779	18,844	18,909	18,975	19,041	19,106
51	19,172	19,238	19,304	19,370	19,437	19,503	19,570	19,636	19,703	19,770
52	19,837	19,904	19,971	20,039	20,106	20,174	20,241	20,309	20,377	20,445
53	20,513	20,581	20,649	20,718	20,786	20,855	20,924	20,993	21,062	21,131
54	21,200	21,269	21,339	21,408	21,478	21,548	21,618	21,688	21,758	21,828
55	21,898	21,969	22,039	22,110	22,181	22,251	22,322	22,393	22,465	22,536
56	22,607	22,679	22,751	22,822	22,894	22,956	23,038	23,111	23,183	23,255
57	23,328	23,400	23,473	23,546	23,619	23,692	23,765	23,839	23,912	23,986
58	24,059	24,133	24,207	24,281	24,355	24,429	24,503	24,578	24,652	24,727
59	24,802	24,877	24,952	25,027	25,102	25,177	25,253	25,328	25,404	25,480
60	25,556	25,632	25,708	25,784	25,860	25,937	25,013	26,090	26,167	26,243

TABLE No. XVIII.

SLOPE  $1\frac{1}{2}$  TO 1.  
CONTENT FOR AVERAGE DEPTHS, BASE 28 FEET.

Feet	0	1	2	3	4	5	6	7	8	9
	e. yds.									
0	0	10	20	31	42	53	64	75	86	97
1	109	120	132	144	156	168	180	192	204	217
2	229	242	255	267	280	293	307	320	333	347
3	361	374	388	402	416	431	445	459	474	488
4	503	518	533	548	563	579	594	610	625	641
5	657	673	689	705	721	738	754	771	788	805
6	822	839	856	873	891	908	926	944	962	980
7	998	1,016	1,034	1,043	1,061	1,080	1,099	1,117	1,136	1,155
8	1,185	1,204	1,223	1,243	1,263	1,282	1,302	1,322	1,342	1,363
9	1,383	1,403	1,424	1,444	1,465	1,486	1,507	1,528	1,549	1,571
10	1,592	1,614	1,635	1,657	1,679	1,701	1,723	1,745	1,768	1,790
11	1,812	1,835	1,858	1,881	1,904	1,927	1,950	1,973	1,997	2,020
12	2,044	2,068	2,092	2,116	2,140	2,164	2,188	2,213	2,237	2,262
13	2,287	2,311	2,336	2,361	2,387	2,412	2,437	2,463	2,489	2,514
14	2,540	2,566	2,592	2,619	2,645	2,671	2,698	2,724	2,751	2,778
15	2,805	2,832	2,858	2,887	2,914	2,942	2,969	2,997	3,025	3,053
16	3,081	3,109	3,137	3,166	3,194	3,223	3,252	3,281	3,310	3,339
17	3,368	3,397	3,427	3,456	3,486	3,516	3,546	3,576	3,606	3,636
18	3,667	3,697	3,727	3,758	3,789	3,819	3,850	3,881	3,913	3,944
19	3,975	4,007	4,039	4,070	4,102	4,134	4,166	4,199	4,231	4,263
20	4,296	4,328	4,361	4,394	4,427	4,460	4,493	4,527	4,560	4,594
21	4,627	4,661	4,695	4,729	4,763	4,797	4,832	4,866	4,900	4,935
22	4,970	5,005	5,040	5,075	5,110	5,145	5,181	5,216	5,252	5,288
23	5,324	5,360	5,396	5,432	5,468	5,505	5,541	5,578	5,615	5,651
24	5,688	5,725	5,763	5,800	5,837	5,875	5,913	5,950	5,988	6,026
25	6,064	6,103	6,141	6,179	6,218	6,256	6,295	6,334	6,373	6,412
26	6,451	6,491	6,530	6,570	6,609	6,649	6,689	6,729	6,769	6,809
27	6,850	6,890	6,930	6,971	7,012	7,053	7,094	7,135	7,176	7,217
28	7,259	7,300	7,342	7,384	7,426	7,468	7,510	7,552	7,594	7,637
29	7,679	7,722	7,765	7,807	7,850	7,893	7,937	7,980	8,023	8,067
30	8,111	8,154	8,198	8,242	8,286	8,331	8,375	8,419	8,464	8,508
31	8,553	8,598	8,643	8,688	8,733	8,779	8,824	8,870	8,915	8,961
32	9,007	9,053	9,099	9,145	9,191	9,238	9,284	9,331	9,378	9,425
33	9,472	9,519	9,566	9,613	9,661	9,708	9,756	9,804	9,852	9,900
34	9,948	9,996	10,044	10,093	10,141	10,190	10,239	10,287	10,336	10,385
35	10,435	10,484	10,533	10,583	10,633	10,682	10,732	10,782	10,832	10,883
36	10,933	10,983	11,034	11,084	11,135	11,186	11,237	11,288	11,339	11,391
37	11,442	11,494	11,545	11,597	11,649	11,701	11,753	11,805	11,858	11,910
38	11,962	12,015	12,068	12,121	12,174	12,227	12,280	12,333	12,387	12,440
39	12,494	12,548	12,602	12,656	12,710	12,764	12,818	12,873	12,927	12,982
40	13,037	13,091	13,146	13,201	13,257	13,312	13,367	13,423	13,479	13,534
41	13,590	13,646	13,702	13,759	13,815	13,871	13,928	13,984	14,041	14,098
42	14,155	14,212	14,269	14,327	14,384	14,442	14,499	14,557	14,615	14,673
43	14,731	14,789	14,848	14,906	14,964	15,023	15,082	15,141	15,200	15,259
44	15,318	15,377	15,437	15,496	15,556	15,616	15,676	15,736	15,796	15,856
45	15,917	15,977	16,038	16,098	16,159	16,221	16,282	16,344	16,405	16,466
46	16,526	16,587	16,649	16,711	16,773	16,835	16,897	16,959	17,021	17,084
47	17,146	17,209	17,272	17,335	17,398	17,461	17,524	17,587	17,651	17,714
48	17,778	17,842	17,905	17,969	18,033	18,098	18,162	18,226	18,291	18,356
49	18,420	18,485	18,550	18,615	18,681	18,746	18,811	18,877	18,942	19,008
50	19,074	19,140	19,206	19,272	19,339	19,405	19,472	19,538	19,605	19,672
51	19,739	19,806	19,873	19,941	20,008	20,076	20,143	20,211	20,279	20,347
52	20,415	20,483	20,551	20,620	20,688	20,757	20,826	20,895	20,964	21,033
53	21,102	21,171	21,241	21,310	21,380	21,450	21,519	21,589	21,659	21,730
54	21,800	21,870	21,941	22,012	22,082	22,153	22,224	22,295	22,367	22,438
55	22,509	22,581	22,652	22,724	22,796	22,868	22,940	23,012	23,085	23,157
56	23,230	23,302	23,375	23,448	23,521	23,594	23,667	23,740	23,814	23,887
57	23,961	24,035	24,109	24,183	24,257	24,331	24,405	24,480	24,554	24,629
58	24,704	24,779	24,854	24,920	25,004	25,079	25,155	25,230	25,306	25,382
59	25,457	25,533	25,609	25,686	25,762	25,838	25,915	25,992	26,068	26,145
60	26,222	26,299	26,377	26,454	26,531	26,609	26,686	26,764	26,842	26,920

TABLE No. XIX.

SLOPE  $1\frac{1}{2}$  TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 30 FEET.

Feet.	0 c. yds.	1 c. yds.	2 c. yds.	3 c. yds.	4 c. yds.	5 c. yds.	6 c. yds.	7 c. yds.	8 c. yds.	9 c. yds.
0	0	11	22	34	45	57	69	80	92	104
1	117	129	141	154	166	179	192	205	218	231
2	244	258	271	285	299	312	326	340	355	369
3	383	398	412	427	442	457	472	487	502	518
4	533	549	565	580	596	612	629	645	661	678
5	694	711	728	745	762	779	796	814	831	849
6	867	884	902	920	939	957	975	994	1,012	1,031
7	1,050	1,069	1,088	1,107	1,126	1,146	1,165	1,185	1,205	1,224
8	1,244	1,264	1,285	1,305	1,325	1,346	1,366	1,387	1,408	1,429
9	1,450	1,471	1,492	1,514	1,535	1,557	1,579	1,600	1,622	1,644
10	1,667	1,689	1,711	1,734	1,756	1,779	1,802	1,825	1,848	1,871
11	1,894	1,918	1,941	1,965	1,988	2,012	2,036	2,060	2,084	2,109
12	2,133	2,158	2,182	2,207	2,232	2,257	2,282	2,307	2,332	2,358
13	2,383	2,409	2,435	2,460	2,486	2,512	2,539	2,565	2,591	2,618
14	2,644	2,671	2,698	2,725	2,752	2,779	2,806	2,834	2,861	2,889
15	2,917	2,944	2,972	3,000	3,029	3,057	3,085	3,114	3,142	3,171
16	3,200	3,229	3,258	3,287	3,316	3,346	3,375	3,405	3,435	3,464
17	3,494	3,524	3,553	3,585	3,615	3,646	3,676	3,707	3,738	3,769
18	3,800	3,831	3,862	3,894	3,925	3,957	3,989	4,020	4,052	4,084
19	4,117	4,149	4,181	4,214	4,246	4,279	4,312	4,345	4,378	4,411
20	4,444	4,478	4,511	4,545	4,579	4,612	4,646	4,680	4,715	4,749
21	4,783	4,818	4,852	4,887	4,922	4,957	4,992	5,027	5,062	5,098
22	5,133	5,169	5,205	5,240	5,276	5,312	5,349	5,385	5,421	5,458
23	5,494	5,531	5,568	5,605	5,642	5,679	5,716	5,754	5,791	5,829
24	5,867	5,904	5,942	5,980	6,018	6,057	6,095	6,134	6,172	6,212
25	6,250	6,289	6,328	6,367	6,406	6,446	6,485	6,525	6,565	6,604
26	6,644	6,684	6,725	6,765	6,805	6,846	6,886	6,927	6,968	7,009
27	7,050	7,091	7,132	7,174	7,215	7,257	7,299	7,340	7,382	7,424
28	7,467	7,509	7,551	7,594	7,636	7,679	7,722	7,765	7,808	7,851
29	7,894	7,938	7,981	8,025	8,069	8,112	8,156	8,200	8,245	8,289
30	8,333	8,378	8,422	8,467	8,512	8,557	8,602	8,647	8,692	8,738
31	8,783	8,829	8,875	8,920	8,966	9,012	9,059	9,105	9,151	9,198
32	9,244	9,291	9,338	9,385	9,432	9,479	9,526	9,574	9,621	9,669
33	9,717	9,764	9,812	9,860	9,909	9,957	10,005	10,054	10,102	10,151
34	10,200	10,249	10,298	10,347	10,396	10,446	10,495	10,545	10,595	10,644
35	10,694	10,744	10,795	10,845	10,895	10,946	10,996	11,047	11,098	11,149
36	11,200	11,251	11,302	11,354	11,405	11,457	11,507	11,560	11,612	11,664
37	11,717	11,769	11,821	11,874	11,926	11,979	12,032	12,085	12,138	12,191
38	12,244	12,298	12,351	12,404	12,459	12,512	12,566	12,620	12,675	12,729
39	12,783	12,838	12,892	12,947	13,002	13,057	13,112	13,167	13,222	13,278
40	13,333	13,389	13,445	13,500	13,556	13,612	13,669	13,725	13,781	13,838
41	13,894	13,951	14,008	14,065	14,122	14,179	14,236	14,294	14,351	14,409
42	14,467	14,524	14,582	14,640	14,699	14,757	14,815	14,874	14,932	14,991
43	15,050	15,109	15,168	15,227	15,286	15,346	15,405	15,465	15,525	15,584
44	15,644	15,704	15,765	15,825	15,885	15,946	16,006	16,067	16,128	16,189
45	16,250	16,311	16,372	16,434	16,495	16,557	16,619	16,681	16,742	16,805
46	16,867	16,928	16,991	17,054	17,116	17,179	17,242	17,305	17,368	17,431
47	17,494	17,558	17,621	17,685	17,749	17,813	17,876	17,941	18,005	18,069
48	18,133	18,198	18,262	18,327	18,392	18,457	18,522	18,587	18,652	18,718
49	18,783	18,849	18,915	18,980	19,046	19,113	19,179	19,245	19,311	19,378
50	19,444	19,511	19,578	19,645	19,712	19,779	19,846	19,914	19,981	20,049
51	20,117	20,185	20,252	20,321	20,389	20,457	20,525	20,594	20,662	20,731
52	20,800	20,869	20,938	21,007	21,076	21,146	21,215	21,285	21,355	21,425
53	21,494	21,565	21,635	21,705	21,775	21,846	21,916	21,987	22,058	22,129
54	22,200	22,271	22,342	22,414	22,485	22,557	22,629	22,701	22,772	22,845
55	22,917	22,989	23,061	23,134	23,206	23,279	23,352	23,425	23,498	23,571
56	23,644	23,718	23,791	23,865	23,939	24,013	24,086	24,161	24,235	24,309
57	24,383	24,458	24,532	24,607	24,682	24,757	24,832	24,907	24,982	25,058
58	25,133	25,209	25,285	25,361	25,436	25,513	25,589	25,665	25,741	25,818
59	25,894	25,971	26,048	26,125	26,202	26,279	26,356	26,434	26,511	26,589
60	26,667	26,745	26,822	26,901	26,979	27,057	27,135	27,214	27,292	27,371

TABLE No. XX.

SLOPE  $1\frac{1}{2}$  TO 1.

CONTENT FOR AVERAGE DEPTHS, BASE 34 FEET.

Feet.	0	1	2	3	4	5	6	7	8	9
	c. yds.									
0	0	13	25	38	51	64	78	91	104	118
1	131	145	159	173	187	201	216	230	245	259
2	274	289	304	319	334	350	365	381	396	412
3	428	444	460	476	492	509	525	542	559	576
4	593	610	627	644	662	679	697	715	732	750
5	769	787	805	823	842	861	879	898	917	936
6	956	975	994	1,014	1,033	1,053	1,073	1,093	1,113	1,133
7	1,154	1,174	1,195	1,215	1,236	1,257	1,278	1,299	1,320	1,342
8	1,363	1,385	1,406	1,428	1,450	1,472	1,494	1,516	1,538	1,561
9	1,583	1,606	1,629	1,652	1,675	1,698	1,721	1,744	1,768	1,791
10	1,815	1,839	1,862	1,886	1,911	1,935	1,959	1,983	2,008	2,033
11	2,057	2,082	2,107	2,132	2,158	2,183	2,208	2,234	2,259	2,285
12	2,311	2,337	2,363	2,389	2,416	2,442	2,469	2,495	2,522	2,549
13	2,576	2,603	2,630	2,658	2,685	2,713	2,740	2,768	2,796	2,824
14	2,852	2,880	2,908	2,937	2,965	2,994	3,023	3,052	3,081	3,110
15	3,139	3,165	3,198	3,227	3,257	3,287	3,316	3,346	3,377	3,407
16	3,437	3,467	3,498	3,529	3,559	3,590	3,621	3,652	3,684	3,715
17	3,746	3,778	3,809	3,841	3,873	3,905	3,937	3,969	4,002	4,034
18	4,067	4,099	4,132	4,165	4,198	4,231	4,264	4,298	4,331	4,365
19	4,398	4,432	4,466	4,500	4,534	4,568	4,602	4,637	4,671	4,706
20	4,741	4,776	4,811	4,846	4,881	4,916	4,952	4,987	5,023	5,059
21	5,094	5,130	5,167	5,203	5,239	5,275	5,312	5,349	5,385	5,422
22	5,459	5,486	5,524	5,561	5,608	5,646	5,683	5,721	5,759	5,797
23	5,835	5,873	5,912	5,950	5,989	6,027	6,066	6,105	6,144	6,183
24	6,222	6,262	6,301	6,341	6,380	6,420	6,460	6,500	6,540	6,580
25	6,620	6,661	6,701	6,742	6,783	6,824	6,865	6,906	6,947	6,988
26	7,030	7,071	7,113	7,155	7,196	7,238	7,281	7,323	7,365	7,407
27	7,450	7,493	7,535	7,578	7,621	7,664	7,708	7,751	7,794	7,838
28	7,881	7,925	7,969	8,013	8,057	8,101	8,146	8,190	8,235	8,279
29	8,324	8,369	8,414	8,459	8,504	8,550	8,595	8,641	8,686	8,732
30	8,778	8,824	8,870	8,916	8,962	9,009	9,055	9,102	9,149	9,196
31	9,243	9,290	9,337	9,384	9,432	9,479	9,527	9,575	9,622	9,670
32	9,719	9,767	9,815	9,863	9,912	9,961	10,009	10,058	10,107	10,156
33	10,206	10,255	10,304	10,354	10,403	10,453	10,503	10,553	10,603	10,653
34	10,704	10,754	10,805	10,855	10,906	10,957	11,008	11,059	11,110	11,162
35	11,213	11,265	11,316	11,368	11,420	11,472	11,524	11,576	11,628	11,681
36	11,733	11,786	11,839	11,892	11,945	11,998	12,051	12,104	12,158	12,211
37	12,265	12,319	12,372	12,426	12,481	12,533	12,589	12,643	12,698	12,753
38	12,807	12,862	12,917	12,972	13,028	13,083	13,138	13,194	13,249	13,305
39	13,361	13,417	13,473	13,529	13,586	13,642	13,699	13,755	13,812	13,869
40	13,926	13,983	14,040	14,098	14,155	14,213	14,270	14,328	14,386	14,444
41	14,502	14,560	14,618	14,677	14,735	14,794	14,853	14,912	14,971	15,030
42	15,089	15,148	15,208	15,267	15,327	15,387	15,446	15,506	15,567	15,627
43	15,687	15,747	15,808	15,869	15,929	15,990	16,051	16,112	16,174	16,235
44	16,296	16,358	16,419	16,481	16,543	16,605	16,667	16,729	16,792	16,854
45	16,917	16,979	17,042	17,105	17,168	17,231	17,294	17,358	17,421	17,485
46	17,548	17,612	17,676	17,740	17,804	17,868	17,932	17,997	18,061	18,126
47	18,191	18,256	18,321	18,386	18,451	18,516	18,582	18,647	18,713	18,779
48	18,844	18,910	18,977	19,043	19,109	19,175	19,242	19,309	19,375	19,442
49	19,509	19,576	19,644	19,711	19,778	19,846	19,913	19,981	20,049	20,117
50	20,185	20,253	20,322	20,390	20,459	20,527	20,596	20,665	20,734	20,803
51	20,872	20,942	21,011	21,081	21,150	21,220	21,290	21,360	21,431	21,500
52	21,570	21,641	21,711	21,782	21,853	21,924	21,995	22,066	22,137	22,208
53	22,280	22,351	22,423	22,493	22,566	22,638	22,711	22,783	22,855	22,927
54	23,000	23,073	23,145	23,218	23,291	23,364	23,438	23,511	23,584	23,658
55	23,731	23,805	23,879	23,953	24,027	24,101	24,176	24,250	24,325	24,399
56	24,474	24,549	24,624	24,699	24,774	24,850	24,925	25,001	25,076	25,152
57	25,229	25,304	25,380	25,456	25,532	25,609	25,685	25,762	25,839	25,916
58	25,993	26,070	26,147	26,224	26,302	26,379	26,457	26,535	26,612	26,690
59	26,769	26,847	26,925	27,003	27,082	27,161	27,239	27,318	27,397	27,476
60	27,556	27,635	27,714	27,794	27,873	27,953	28,033	28,113	28,193	28,273

TABLE No. XXI.  
SLOPE  $1\frac{1}{2}$  TO 1.  
CORRECTION FOR DIFFERENCES OF DEPTHS.

Fest.	0 c. yds.	1 c. yds.	2 c. yds.	3 c. yds.	4 c. yds.	5 c. yds.	6 c. yds.	7 c. yds.	8 c. yds.	9 c. yds.
1	0	1	1	1	1	1	1	1	2	2
2	2	2	2	2	3	3	3	3	4	4
3	4	4	5	5	5	6	6	6	7	7
4	7	8	8	9	9	9	10	10	11	11
5	12	12	13	13	14	14	15	15	16	16
6	17	17	18	18	19	20	21	21	22	22
7	23	23	24	25	25	26	27	27	28	29
8	30	30	31	32	33	33	34	35	36	37
9	37	38	39	40	41	42	43	44	44	45
10	46	47	48	49	50	51	52	53	54	55
11	56	57	58	59	60	61	62	63	64	66
12	67	68	69	70	71	72	74	75	76	77
13	78	79	81	82	83	84	86	87	88	89
14	91	92	93	95	96	97	99	100	101	103
15	104	106	107	108	110	111	113	114	116	117
16	119	120	122	123	125	126	128	129	131	132
17	134	135	137	139	140	142	143	145	147	148
18	150	152	153	155	157	158	160	162	164	165
19	167	169	171	172	174	176	178	180	181	183
20	185	187	189	191	193	195	196	198	200	202
21	204	206	208	210	212	214	216	218	220	222
22	224	226	228	230	232	234	236	239	241	243
23	245	247	249	251	253	256	258	260	262	264
24	267	269	271	273	276	278	280	282	285	287
25	289	292	294	296	299	301	303	306	308	311
26	313	315	318	320	323	325	328	330	333	335
27	337	340	343	345	348	350	353	355	358	360
28	363	366	368	371	373	376	379	381	384	387
29	389	392	395	397	400	403	406	408	411	414
30	417	419	422	425	428	431	433	436	439	442
31	445	448	451	453	456	459	462	465	468	471
32	474	477	480	483	486	489	492	495	498	501
33	504	507	510	513	516	519	523	526	529	532
34	535	538	542	545	548	551	554	557	561	564
35	567	570	574	577	580	583	587	590	593	597
36	600	603	607	610	614	617	620	624	627	630
37	634	637	641	644	648	651	654	658	661	665
38	668	692	675	679	683	686	690	693	697	701
39	704	708	711	715	719	722	726	730	733	737
40	741	744	748	752	756	759	763	767	771	774
41	778	782	786	790	793	797	801	805	809	813
42	817	821	824	828	832	836	840	844	848	852
43	856	860	864	868	872	876	880	884	888	892
44	896	900	904	908	913	917	921	925	929	933
45	938	942	946	950	954	958	963	967	971	975

TABLE No. XXII.

(CONTINUED.)

## CONTENTS OF PRISMS WITH SQUARE BASES.

Feet	0	1	2	3	4	5	6	7	8	9.
	c. yds.									
122	55,126	55,216	55,307	55,397	55,488	55,579	55,669	55,760	55,851	55,942
123	56,033	56,124	56,216	56,307	56,398	56,490	56,581	56,673	56,765	56,856
124	56,948	57,040	57,132	57,224	57,316	57,408	57,501	57,593	57,685	57,778
125	57,870	57,963	58,056	58,148	58,241	58,334	58,427	58,520	58,613	58,707
126	58,800	58,893	58,987	59,080	59,174	59,268	59,361	59,455	59,549	59,643
127	59,737	59,831	59,925	60,020	60,114	60,208	60,303	60,397	60,492	60,587
128	60,681	60,776	60,871	60,966	61,061	61,156	61,252	61,347	61,442	61,538
129	61,633	61,729	61,825	61,920	62,016	62,112	62,208	62,304	62,400	62,496
130	62,593	62,689	62,785	62,882	62,978	63,075	63,172	63,268	63,365	63,462
131	63,559	63,656	63,753	63,851	63,948	64,045	64,143	64,240	64,338	64,436
132	64,533	64,631	64,729	64,827	64,925	65,023	65,121	65,220	65,318	65,416
133	65,515	65,613	65,712	65,811	65,909	66,008	66,107	66,206	66,305	66,404
134	66,504	66,603	66,702	66,802	66,901	67,001	67,101	67,200	67,300	67,400
135	67,500	67,600	67,700	67,800	67,901	68,001	68,101	68,202	68,302	68,403
136	68,504	68,604	68,705	68,806	68,907	69,008	69,109	69,210	69,312	69,413
137	69,515	69,616	69,718	69,820	69,921	70,023	70,125	70,227	70,329	70,431
138	70,533	70,636	70,738	70,840	70,943	71,045	71,148	71,251	71,353	71,456
139	71,559	71,662	71,765	71,868	71,972	72,075	72,178	72,282	72,385	72,489
140	72,593	72,696	72,800	72,904	73,008	73,112	73,216	73,320	73,425	73,529
141	73,633	73,738	73,842	73,947	74,052	74,156	74,261	74,366	74,471	74,576
142	74,681	74,787	74,892	74,997	75,103	75,208	75,314	75,420	75,525	75,631
143	75,737	75,843	75,949	76,055	76,161	76,268	76,374	76,480	76,587	76,693
144	76,800	76,907	77,013	77,120	77,227	77,334	77,441	77,548	77,656	77,763
145	77,870	77,978	78,085	78,193	78,301	78,408	78,516	78,624	78,732	78,840
146	78,948	79,056	79,163	79,273	79,381	79,490	79,598	79,707	79,816	79,924
147	80,033	80,142	80,251	80,360	80,469	80,579	80,688	80,797	80,907	81,016
148	81,126	81,236	81,345	81,455	81,565	81,675	81,785	81,895	82,005	82,116
149	82,226	82,336	82,447	82,557	82,668	82,779	82,889	83,000	83,111	83,222
150	83,333	83,444	83,556	83,667	83,778	83,890	84,001	84,112	84,225	84,336
151	84,448	84,560	84,672	84,784	84,896	85,008	85,121	85,233	85,345	85,458
152	85,570	85,683	85,796	85,908	86,021	86,134	86,247	86,360	86,473	86,587
153	86,700	86,813	86,927	87,040	87,154	87,268	87,381	87,495	87,609	87,723
154	87,837	87,951	88,065	88,180	88,294	88,408	88,523	88,637	88,752	88,867
155	88,981	89,096	89,211	89,326	89,441	89,556	89,672	89,787	89,902	90,018
156	90,133	90,249	90,365	90,480	90,596	90,712	90,828	90,944	91,060	91,176
157	91,293	91,409	91,525	91,642	91,758	91,875	91,992	92,108	92,225	92,342
158	92,459	92,576	92,693	92,811	92,928	93,045	93,163	93,280	93,398	93,516
159	93,633	93,751	93,869	93,987	94,105	94,223	94,341	94,460	94,578	94,696
160	94,815	94,933	95,052	95,171	95,289	95,408	95,527	95,646	95,765	95,884
161	96,004	96,123	96,242	96,362	96,481	96,601	96,721	96,840	96,960	97,080
162	97,200	97,320	97,440	97,560	97,681	97,801	97,921	98,042	98,162	98,283
163	98,404	98,524	98,645	98,766	98,887	99,008	99,129	99,251	99,372	99,493
164	99,615	99,736	99,858	99,980	100,101	100,223	100,345	100,467	100,589	100,711
165	100,833	100,956	101,078	101,200	101,323	101,445	101,568	101,691	101,813	101,936
166	102,159	102,182	102,305	102,428	102,552	102,675	102,798	102,922	103,045	103,169
167	103,293	103,416	103,540	103,664	103,788	103,912	104,036	104,160	104,285	104,409
168	104,533	104,658	104,782	104,907	105,032	105,256	105,381	105,406	105,531	105,656
169	105,781	105,907	106,032	106,157	106,283	106,408	106,534	106,660	106,785	106,911
170	107,037	107,163	107,289	107,415	107,541	107,668	107,794	107,920	108,047	108,173
171	108,300	108,427	108,553	108,680	108,807	108,934	109,061	109,188	109,316	109,443
172	109,570	109,698	109,825	109,953	110,081	110,208	110,336	110,464	110,592	110,720
173	110,848	110,976	111,105	111,233	111,361	111,490	111,618	111,747	111,876	112,004
174	112,133	112,262	112,391	112,520	112,649	112,779	112,908	113,037	113,167	113,296
175	113,426	113,556	113,685	113,815	113,945	114,075	114,205	114,335	114,465	114,596
176	114,726	114,856	114,987	115,117	115,248	115,379	115,509	115,640	115,771	115,902
177	116,033	116,164	116,296	116,427	116,558	116,690	116,821	116,953	117,085	117,216
178	117,348	117,480	117,612	117,744	117,876	118,008	118,141	118,273	118,405	118,538
179	118,670	118,803	118,936	119,068	119,201	119,334	119,467	119,600	119,733	119,867
180	120,000	120,133	120,267	120,400	120,534	120,668	120,801	120,935	121,069	121,203
181	121,337	121,471	121,605	121,740	121,874	122,008	122,143	122,277	122,412	122,547
182	122,681	122,816	122,951	123,086	123,221	123,356	123,492	123,627	123,762	123,898

TABLE No. XXII.

(CONTINUED.)

CONTENTS OF PRISMS WITH SQUARE BASES.

Feet.	Contents of Prisms with Square Bases.									
	0	1	2	3	4	5	6	7	8	9
c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	c. yds.	
61	13,781	13,827	13,872	13,917	13,963	14,008	14,054	14,100	14,145	14,191
62	14,237	14,283	14,329	14,375	14,421	14,468	14,514	14,560	14,607	14,653
63	14,700	14,747	14,793	14,840	14,887	14,934	14,981	15,028	15,076	15,123
64	15,170	15,218	15,265	15,313	15,361	15,408	15,456	15,504	15,552	15,600
65	15,648	15,696	15,745	15,793	15,841	15,890	15,938	15,987	16,036	16,084
66	16,133	16,182	16,231	16,280	16,329	16,379	16,428	16,477	16,527	16,576
67	16,626	16,676	16,725	16,775	16,825	16,875	16,925	16,975	17,025	17,076
68	17,126	17,176	17,227	17,277	17,328	17,379	17,429	17,480	17,531	17,582
69	17,633	17,684	17,736	17,787	17,838	17,890	17,941	17,993	18,045	18,096
70	18,148	18,200	18,252	18,304	18,356	18,408	18,461	18,513	18,565	18,618
71	18,670	18,723	18,776	18,828	18,881	18,934	18,987	19,040	19,093	19,147
72	19,200	19,253	19,307	19,360	19,414	19,468	19,521	19,575	19,629	19,683
73	19,737	19,791	19,845	19,900	19,954	20,008	20,063	20,117	20,172	20,227
74	20,281	20,336	20,391	20,446	20,501	20,556	20,612	20,667	20,722	20,778
75	20,833	20,889	20,945	21,000	21,056	21,112	21,168	21,224	21,280	21,336
76	21,393	21,449	21,505	21,562	21,618	21,675	21,732	21,788	21,845	21,902
77	21,959	22,016	22,073	22,131	22,188	22,245	22,303	22,360	22,418	22,476
78	22,533	22,591	22,649	22,707	22,765	22,823	22,881	22,940	22,998	23,056
79	23,115	23,173	23,232	23,291	23,349	23,408	23,467	23,526	23,585	23,644
80	23,704	23,763	23,822	23,882	23,941	24,001	24,061	24,120	24,180	24,240
81	24,300	24,360	24,420	24,480	24,541	24,601	24,661	24,722	24,783	24,843
82	24,904	24,965	25,025	25,086	25,147	25,208	25,269	25,331	25,392	25,453
83	25,515	25,576	25,638	25,700	25,761	25,823	25,885	25,947	26,009	26,071
84	26,133	26,196	26,258	26,320	26,383	26,445	26,508	26,571	26,633	26,696
85	26,759	26,822	26,885	26,948	27,012	27,075	27,138	27,202	27,265	27,329
86	27,393	27,456	27,520	27,584	27,648	27,712	27,776	27,840	27,905	27,969
87	28,033	28,098	28,162	28,227	28,292	28,356	28,421	28,486	28,551	28,616
88	28,681	28,747	28,812	28,877	28,943	29,008	29,074	29,140	29,205	29,271
89	29,337	29,403	29,469	29,535	29,601	29,668	29,734	29,800	29,867	29,933
90	30,000	30,067	30,133	30,200	30,267	30,334	30,401	30,468	30,536	30,603
91	30,670	30,738	30,805	30,873	30,941	31,008	31,076	31,144	31,212	31,280
92	31,348	31,416	31,485	31,553	31,621	31,690	31,758	31,827	31,896	31,964
93	32,033	32,102	32,171	32,240	32,309	32,379	32,448	32,517	32,587	32,656
94	32,726	32,796	32,865	32,935	33,005	33,075	33,145	33,215	33,285	33,356
95	33,426	33,496	33,567	33,637	33,708	33,779	33,849	33,920	33,991	34,062
96	34,133	34,204	34,276	34,347	34,418	34,490	34,561	34,633	34,705	34,776
97	34,848	34,920	34,992	35,064	35,136	35,208	35,281	35,353	35,425	35,498
98	35,570	35,643	35,716	35,788	35,861	35,934	36,007	36,080	36,153	36,227
99	36,300	36,373	36,447	36,520	36,594	36,668	36,741	36,815	36,889	36,963
100	37,037	37,111	37,185	37,260	37,334	37,408	37,483	37,557	37,632	37,707
101	37,781	37,856	37,931	38,006	38,081	38,156	38,232	38,307	38,382	38,458
102	38,533	38,609	38,685	38,760	38,836	38,912	38,988	39,064	39,140	39,216
103	39,293	39,369	39,445	39,522	39,598	39,675	39,752	39,828	39,905	39,982
104	40,059	40,136	40,213	40,291	40,368	40,445	40,523	40,600	40,678	40,756
105	40,833	40,911	40,989	41,067	41,145	41,223	41,301	41,380	41,458	41,536
106	41,615	41,693	41,772	41,851	41,929	42,008	42,087	42,166	42,245	42,324
107	42,404	42,483	42,562	42,642	42,721	42,801	42,881	42,960	43,040	43,120
108	43,200	43,280	43,360	43,440	43,521	43,601	43,681	43,762	43,842	43,923
109	44,004	44,084	44,165	44,246	44,327	44,408	44,489	44,571	44,652	44,733
110	44,815	44,896	44,978	45,060	45,141	45,223	45,305	45,387	45,469	45,551
111	45,633	45,716	45,798	45,880	45,963	46,045	46,128	46,211	46,293	46,376
112	46,459	46,542	46,625	46,708	46,792	46,875	46,958	47,042	47,125	47,209
113	47,293	47,376	47,460	47,544	47,628	47,712	47,796	47,880	47,965	48,049
114	48,133	48,218	48,302	48,387	48,472	48,556	48,641	48,726	48,811	48,896
115	48,981	49,067	49,152	49,237	49,323	49,408	49,494	49,580	49,665	49,751
116	49,837	49,923	50,009	50,095	50,181	50,268	50,354	50,440	50,527	50,613
117	50,700	50,787	50,873	50,960	51,047	51,134	51,221	51,308	51,396	51,483
118	51,570	51,658	51,745	51,833	51,920	52,008	52,096	52,184	52,272	52,360
119	52,448	52,536	52,625	52,713	52,801	52,890	52,978	53,067	53,156	53,244
120	53,333	53,422	53,511	53,600	53,689	53,779	53,868	53,957	54,047	54,136
121	54,226	54,316	54,405	54,495	54,585	54,675	54,765	54,855	54,945	55,036

TABLE No. XXII.

CONTENTS OF PRISMS WITH SQUARE BASES.

Feet	0 c. yds.	1 c. yds.	2 c. yds.	3 c. yds.	4 c. yds.	5 c. yds.	6 c. yds.	7 c. yds.	8 c. yds.	9 c. yds.
0	0	0	0	0	1	1	1	2	2	3
1	4	4	5	6	7	8	9	11	12	13
2	15	16	18	20	21	23	25	27	29	31
3	33	36	38	40	43	45	48	51	53	56
4	59	62	65	68	72	75	78	82	85	89
5	93	96	100	104	108	112	116	120	125	129
6	133	138	142	147	152	156	161	166	171	176
7	181	187	192	197	203	208	214	220	225	231
8	237	243	249	255	261	268	274	280	287	293
9	300	307	313	320	327	334	341	348	356	363
10	370	378	385	393	401	408	416	424	432	440
11	448	456	465	473	481	490	398	507	516	524
12	533	542	551	560	569	579	588	597	607	616
13	626	636	645	655	665	675	685	695	705	716
14	726	736	747	757	768	779	789	800	811	822
15	833	844	856	867	878	890	901	913	925	936
16	948	960	972	984	996	1,008	1,021	1,033	1,045	1,058
17	1,070	1,083	1,096	1,108	1,121	1,134	1,147	1,160	1,173	1,187
18	1,200	1,213	1,227	1,240	1,254	1,268	1,281	1,295	1,309	1,323
19	1,337	1,351	1,365	1,380	1,394	1,408	1,423	1,437	1,452	1,467
20	1,481	1,496	1,511	1,526	1,541	1,556	1,572	1,587	1,602	1,618
21	1,633	1,649	1,665	1,680	1,696	1,712	1,728	1,744	1,760	1,776
22	1,792	1,809	1,825	1,842	1,858	1,875	1,892	1,908	1,925	1,942
23	1,959	1,976	1,993	2,011	2,028	2,045	2,063	2,080	2,098	2,116
24	2,133	2,151	2,169	2,187	2,205	2,223	2,241	2,260	2,278	2,296
25	2,315	2,333	2,352	2,371	2,389	2,408	2,427	2,446	2,465	2,484
26	2,504	2,523	2,542	2,562	2,581	2,601	2,621	2,640	2,660	2,680
27	2,700	2,720	2,740	2,760	2,781	2,801	2,821	2,842	2,862	2,883
28	2,904	2,924	2,945	2,966	2,987	3,008	3,029	3,051	3,072	3,093
29	3,115	3,136	3,158	3,180	3,201	3,223	3,245	3,267	3,289	3,311
30	3,333	3,353	3,378	3,400	3,423	3,445	3,468	3,491	3,513	3,536
31	3,559	3,582	3,605	3,628	3,652	3,675	3,698	3,722	3,745	3,769
32	3,793	3,816	3,840	3,864	3,888	3,912	3,936	3,960	3,985	4,009
33	4,033	4,058	4,082	4,107	4,132	4,156	4,181	4,206	4,231	4,256
34	4,281	4,307	4,332	4,357	4,383	4,408	4,434	4,460	4,485	4,511
35	4,537	4,563	4,589	4,615	4,641	4,668	4,694	4,720	4,747	4,773
36	4,800	4,827	4,853	4,880	4,907	4,934	4,961	4,988	5,016	5,043
37	5,070	5,098	5,125	5,153	5,181	5,208	5,236	5,264	5,292	5,320
38	5,348	5,376	5,405	5,433	5,461	5,490	5,518	5,547	5,576	5,604
39	5,633	5,662	5,691	5,720	5,749	5,779	5,808	5,837	5,867	5,896
40	5,926	5,956	5,985	6,015	6,045	6,075	6,105	6,135	6,165	6,196
41	6,226	6,256	6,287	6,317	6,348	6,379	6,409	6,440	6,471	6,502
42	6,533	6,564	6,596	6,627	6,658	6,690	6,721	6,753	6,785	6,816
43	6,848	6,880	6,912	6,944	6,976	7,008	7,041	7,073	7,105	7,138
44	7,170	7,203	7,236	7,268	7,301	7,334	7,367	7,400	7,433	7,467
45	7,500	7,533	7,567	7,600	7,634	7,668	7,701	7,735	7,769	7,803
46	7,837	7,871	7,905	7,940	7,974	8,008	8,043	8,077	8,112	8,147
47	8,181	8,216	8,251	8,286	8,321	8,356	8,392	8,427	8,462	8,498
48	8,533	8,569	8,605	8,640	8,676	8,712	8,748	8,784	8,820	8,856
49	8,893	8,829	8,965	9,002	9,038	9,075	9,112	9,148	9,185	9,222
50	9,259	9,296	9,333	9,371	9,408	9,445	9,483	9,520	9,558	9,596
51	9,633	9,671	9,709	9,747	9,785	9,823	9,861	9,900	9,938	9,976
52	10,015	10,053	10,092	10,131	10,169	10,208	10,247	10,286	10,325	10,364
53	10,404	10,443	10,482	10,522	10,561	10,601	10,641	10,680	10,720	10,760
54	10,800	10,840	10,880	10,920	10,961	11,001	11,041	11,082	11,122	11,163
55	11,204	11,244	11,285	11,326	11,367	11,408	11,449	11,491	11,532	11,573
56	11,615	11,656	11,698	11,740	11,781	11,823	11,865	11,907	11,949	11,991
57	12,033	12,076	12,118	12,160	12,203	12,245	12,288	12,331	12,374	12,416
58	12,459	12,502	12,545	12,588	12,632	12,675	12,718	12,762	12,805	12,849
59	12,893	12,936	12,970	13,014	13,068	13,112	13,156	13,200	13,245	13,289
60	13,333	13,378	13,422	13,467	13,512	13,556	13,601	13,646	13,691	13,736

TABLE No. XXII.

(CONTINUED.)

CONTENTS OF PRISMS WITH SQUARE BASES.

<b>No.</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>	<b>8</b>	<b>9</b>
	c. yds.									
183	124,033	124,169	124,305	124,404	124,576	124,712	124,848	124,984	125,120	125,256
184	124,393	125,529	125,665	125,802	125,938	126,075	126,212	126,348	126,485	126,622
185	126,759	126,896	127,033	127,171	127,308	127,445	127,583	127,720	127,858	127,996
186	128,133	128,271	128,409	128,447	128,685	128,823	128,961	129,100	129,238	129,373
187	129,515	129,653	129,792	129,931	130,069	130,208	130,347	130,486	130,625	130,764
188	130,904	131,043	131,182	131,321	131,461	131,601	131,741	131,880	132,020	132,160
189	132,300	132,440	132,580	132,720	132,861	133,001	133,141	133,282	133,422	133,563
190	133,704	133,844	133,985	134,126	134,267	134,408	134,549	134,691	134,832	134,973
191	135,115	135,256	135,398	135,540	135,681	135,823	135,965	136,107	136,249	136,391
192	136,533	136,676	136,818	136,960	137,103	137,245	137,388	137,531	137,673	137,816
193	137,959	138,102	138,245	138,388	138,532	138,675	138,818	138,962	139,105	139,249
194	139,333	139,536	139,680	139,824	139,968	140,112	140,256	140,400	140,545	140,689
195	140,833	140,978	141,122	141,267	141,412	141,556	141,701	141,846	141,991	142,136
196	142,281	142,427	142,572	142,717	142,823	143,008	143,154	143,300	143,445	143,591
197	143,737	143,883	144,029	144,175	144,321	144,468	144,614	144,760	144,907	145,053
198	145,200	145,347	145,493	145,640	145,787	145,934	146,081	146,228	146,376	146,523
199	146,670	146,818	146,965	147,113	147,261	147,408	147,556	147,704	147,852	148,000
200	148,148	148,296	148,445	148,593	148,741	148,890	149,038	149,187	149,336	149,484

TABLE No. XXIII.

SLOPE  $\frac{1}{2}$  TO 1.

Degrees.	Greater and lesser areas.						Greater and lesser Horizontal distances.						Side distances.			Degrees.
	A	$\frac{1}{2}$	a	$\frac{1}{2}$	A-a	$\frac{1}{2}$	Y	$\frac{1}{2}$	y	$\frac{1}{2}$	Y+y	$\frac{1}{2}$	Dif.	Great-er.	Less-er.	
1·0022	11	0022	10	0000	1	5044	23	4957	22	1·0001	1	-505	496	1		
2·0044	12	0043	10	0002	1	5089	23	4914	21	1·0003	2	-509	492	2		
3·0067	12	0064	10	0004	1	5135	23	4872	20	1·0007	3	-514	488	3		
4·0091	12	0085	10	0006	2	5181	24	4831	20	1·0012	4	-519	484	4		
5·0114	12	0105	10	0010	2	5229	24	4790	20	1·0019	5	-525	481	5		
6·0139	12	0125	10	0014	3	5277	25	4750	19	1·0027	6	-531	478	6		
7·0164	12	0145	10	0019	3	5327	26	4711	19	1·0038	6	-537	475	7		
8·0189	13	0164	10	0025	3	5378	26	4672	19	1·0050	7	-543	472	8		
9·0215	13	0184	10	0032	4	5430	27	4633	19	1·0063	8	-550	469	9		
10·0242	13	0203	10	0039	4	5484	27	4595	19	1·0079	9	-557	467	10		
11·0269	14	0222	9	0048	5	5538	28	4557	18	1·0095	10	-564	464	11		
12·0297	14	0240	9	0057	5	5595	29	4520	18	1·0115	11	-572	462	12		
13·0326	15	0259	9	0068	6	5653	30	4483	18	1·0136	12	-580	460	13		
14·0356	15	0277	9	0079	6	5712	31	4446	18	1·0158	13	-589	458	14		
15·0387	15	0295	9	0091	7	5774	32	4409	18	1·0183	14	-597	457	15		
16·0418	16	0314	9	0105	7	5837	33	4373	18	1·0210	15	-607	455	16		
17·0451	17	0332	9	0120	8	5902	34	4337	18	1·0239	16	-617	454	17		
18·0485	18	0349	9	0136	9	5970	35	4301	18	1·0271	16	-628	452	18		
19·0520	18	0367	9	0153	9	6040	36	4266	18	1·0306	18	-639	451	19		
20·0556	18	0385	9	0171	10	6112	37	4230	18	1·0342	18	-651	450	20		
21·0594	19	0403	9	0191	11	6188	39	4195	17	1·0383	20	-663	449	21		
22·0633	20	0420	9	0213	12	6266	41	4160	17	1·0426	22	-676	449	22		
23·0674	21	0438	9	0236	12	6347	41	4125	17	1·0472	23	-690	448	23		
24·0716	22	0455	9	0261	13	6432	43	4090	17	1·0522	27	-704	448	24		
25·0760	22	0473	9	0287	14	6520	44	4055	17	1·0575	29	-720	447	25		
26·0806	23	0490	9	0316	14	6613	47	4020	17	1·0633	31	-736	447	26		
27·0855	24	0508	9	0347	16	6709	48	3985	17	1·0694	34	-753	447	27		
28·0905	25	0525	9	0380	17	6811	51	3950	17	1·0761	36	-771	447	28		
29·0959	28	0543	9	0416	19	6917	53	3915	17	1·0832	39	-791	448	29		
30·1015	28	0560	9	0455	19	7029	56	3880	17	1·0909	39	-812	448	30		
31·1074	30	0578	9	0496	21	7147	59	3845	17	1·0992	42	-834	449	31		
32·1136	31	0595	9	0541	22	7272	63	3810	17	1·1082	45	-858	449	32		
33·1202	33	0613	9	0589	24	7404	66	3774	18	1·1178	48	-883	450	33		
34·1272	35	0631	9	0642	26	7545	71	3739	18	1·1284	53	-910	451	34		
35·1347	37	0648	9	0699	28	7694	75	3703	18	1·1397	57	-939	452	35		
36·1426	40	0666	9	0760	31	7853	80	3668	18	1·1521	62	-971	453	36		
37·1512	43	0684	9	0827	34	8023	85	3632	18	1·1655	67	-1·005	455	37		
38·1603	46	0702	9	0901	37	8205	91	3595	18	1·1800	73	1·041	456	38		
39·1701	49	0721	9	0981	40	8402	99	3559	18	1·1961	81	1·081	458	39		
40·1807	53	0739	9	1068	44	8614	106	3522	18	1·2136	88	1·125	460	40		
41·1922	58	0757	9	1165	48	8844	115	3485	18	1·2329	97	1·172	462	41		
42·2047	63	0776	9	1271	53	9094	125	3448	18	1·2542	107	1·224	464	42		
43·2184	68	0795	10	1389	59	9368	137	3410	19	1·2778	118	1·281	466	43		
44·2334	75	0814	10	1520	66	9668	150	3372	19	1·3040	131	1·344	469	44		
45·2500	83	0833	10	1667	73	1·0000	166	3333	19	1·3333	147	1·414	471	45		
46·2684	92	0853	10	1832	93	1·0368	184	3294	19	1·3662	165	1·493	474	46		
47·2890	103	0873	10	2018	106	1·0780	206	3255	19	1·4035	187	1·581	477	47		
48·3122	116	0893	10	2230	121	1·1244	232	3215	19	1·4459	217	1·681	481	48		
49·3385	132	0913	10	2472	121	1·1770	263	3174	19	1·4944	243	1·794	484	49		

TABLE No. XXIV.

SLOPE 1 TO 1.

Degrees.	Greater and lesser areas.						Greater and lesser Horizontal distances.						Side distances.	
	A	$\frac{1}{2}$	a	$\frac{1}{2}$	A—a	$\frac{1}{2}$	Y	$\frac{1}{2}$	y	$\frac{1}{2}$	Y+y	$\frac{1}{2}$	Dif.	Greater.
.0089	46	.0086	41	.0003	5	1.0178	92	.9828	S3	2.0006	10	1.018	.983	
.0181	46	.0169	41	.0012	8	1.0362	96	.9663	S8	2.0025	15	1.037	.967	
.0277	48	.0249	40	.0028	11	1.0553	99	.9502	S2	2.0055	22	1.057	.952	
.0376	50	.0327	39	.0049	14	1.0752	104	.9346	S78	2.0098	28	1.078	.937	
.0479	52	.0402	38	.0077	17	1.0959	108	.9196	S75	2.0154	35	1.100	.923	
.0587	54	.0476	37	.0112	21	1.1175	109	.9049	S73	2.0223	42	1.124	.910	
.0700	56	.0547	36	.0153	24	1.1400	118	.8907	S69	2.0306	49	1.149	.897	
.0818	59	.0616	35	.0202	28	1.1635	123	.8768	S68	2.0403	56	1.175	.885	
.0941	63	.0684	34	.0257	32	1.1882	129	.8633	S66	2.0515	64	1.203	.874	
.1070	68	.0750	33	.0321	36	1.2141	136	.8501	S64	2.0642	72	1.233	.863	
.1206	72	.0814	31	.0393	40	1.2413	143	.8373	S63	2.0785	81	1.264	.853	
.1350	76	.0877	31	.0473	45	1.2699	151	.8247	S61	2.0946	90	1.298	.843	
.1501	80	.0938	31	.0563	50	1.3002	160	.8124	S60	2.1126	100	1.334	.834	
.1661	85	.0998	30	.0663	55	1.3321	169	.8004	S59	2.1326	109	1.373	.825	
.1830	90	.1057	29	.0774	61	1.3660	180	.7887	S58	2.1547	119	1.414	.816	
.2010	96	.1114	28	.0896	68	1.4020	192	.7772	S57	2.1792	135	1.459	.808	
.2202	102	.1171	28	.1031	75	1.4404	205	.7659	S57	2.2062	150	1.506	.801	
.2407	110	.1226	27	.1180	82	1.4813	219	.7548	S55	2.2361	165	1.558	.794	
.2626	118	.1281	27	.1345	91	1.5252	236	.7439	S54	2.2690	182	1.613	.787	
.2861	127	.1334	26	.1527	101	1.5723	254	.7332	S53	2.3054	201	1.673	.780	
.3115	137	.1387	26	.1728	111	1.6230	275	.7226	S52	2.3456	223	1.738	.774	
.3390	149	.1439	26	.1951	123	1.6779	298	.7122	S51	2.3902	247	1.810	.768	
.3688	163	.1490	25	.2198	137	1.7375	325	.7020	S50	2.4396	275	1.888	.762	
.4013	178	.1540	25	.2473	153	1.8025	356	.6919	S50	2.4945	275	1.973	.757	
.4369	196	.1590	25	.2779	171	1.8737	392	.6820	S50	2.5557	306	2.067	.752	
.4761	217	.1639	24	.3121	193	1.9521	434	.6722	S49	2.6243	343	2.172	.748	
.5194	242	.1688	24	.3507	218	2.0388	483	.6625	S48	2.7013	385	2.288	.743	
.5677	271	.1736	24	.3942	247	2.1354	541	.6529	S47	2.7883	435	2.418	.739	
.6219	306	.1783	24	.4435	282	2.2437	612	.6434	S47	2.8871	494	2.566	.736	
.6830	348	.1830	23	.5000	325	2.3660	697	.6340	S47	3.0000	565	2.732	.732	
.7527	401	.1877	23	.5650	378	2.5054	802	.6247	S47	3.1301	651	2.923	.729	
.8329	467	.1923	23	.6106	444	2.6657	933	.6154	S46	3.2812	756	3.143	.726	
.9202	550	.1969	23	.7293	28323	1100	6063	.6063	S45	3.4586	887	3.401	.723	
1.0361	659	.2014	23	.8347	527	3.0723	1317	.5972	S45	3.6635	1055	3.705	.720	
1.1679	803	.2059	22	.9619	636	3.3357	1606	.5882	S45	3.9239	1272	4.072	.718	
1.3284	1002	.2149	22	1.1180	781	3.6569	2004	.5792	S45	4.2361	1561	4.520	.716	
1.5289	1286	.2193	22	1.5668	1264	4.0577	2572	.5614	S44	4.6280	1960	5.081	.714	
1.7861	1713	.2237	22	1.9049	1690	4.5722	3425	.5526	S44	5.1336	3381	5.802	.712	
2.1286	2395	.2237	22	2.3794	2373	5.2572	4789	.5437	S44	5.8097	4746	5.765	.711	
2.6075	3588	.2281	22	3.566	62150	7.176	5437	.5374	S44	6.7588	7133	8.113	.710	
3.3252	2325	3.0927	22	7.6503	1951	7.350	5350	.5254	S44	8.1853	1037	10.709		
4.5203	5976	2369	22	4.2834	10406	5262	44	10.5668	S44	1.1908	13511	1708		
6.9091	11944	2413	22	6.6678	148181	5175	44	15.3356	S44	2.3844	20261	2078		
44.0725	35817	2456	22	13.8269	3.5795	29.1450	5087	44	29.6537	7.1591	40.516	707		
45 infinite.		-2500		infinite.		infinite.	5000	44	infinite.	infinite.	infin.	707		

TABLE No. XXV.

**SLOPE 1½ TO 1.**

Greater and lesser areas.		Horizontal distances.										Side distances.			
Degrees		A		$A-a$		$\frac{1}{2}Dif.$		$\frac{1}{2}$		$\frac{1}{2}y$		$\frac{1}{2}y+y$		$\frac{1}{2}$	
Dif.	$\frac{1}{2}$	$a$	$\frac{1}{2}Dif.$	$A$	$\frac{1}{2}Dif.$	$A-a$	$\frac{1}{2}Dif.$	$y$	$\frac{1}{2}Dif.$	$y$	$\frac{1}{2}Dif.$	$y+y$	$\frac{1}{2}Dif.$	$y$	
0202	107	0191	.91	15	.5403	15	.4617	182	.30020	31	1.541	1.463	1	1.584	1.427
2	0415	113	.0547	87	.0041	26	.5829	225	.1423	52	1.631	1.396	2	1.680	1.361
3	0640	119	.0712	83	.0167	37	.6758	254	.1357	74	1.733	1.331	5	1.791	1.304
4	0879	127	.0870	76	.0263	48	.7267	271	.1326	96	1.733	1.331	6	1.853	1.304
5	1133	135	.1021	76	.0382	60	.7508	290	.1267	145	1.733	1.331	7	1.920	1.251
6	1404	145	.1167	73	.0527	72	.8387	310	.1238	139	1.733	1.331	8	1.992	1.227
7	1693	155	.1306	70	.0698	86	1.9008	334	.1212	134	2.1796	200	1.920	1.251	
8	2337	167	.1436	67	.0898	100	1.9676	360	.1186	129	3.2258	231	2.072	1.205	
9	2697	180	.1569	65	.1129	115	2.0396	390	.1162	124	3.2789	266	2.157	1.184	
10	3087	193	.1693	62	.1349	123	2.1176	424	.1137	116	3.3397	304	2.356	1.143	
11	3511	212	.1813	58	.1698	132	2.2024	463	.1113	111	3.4091	347	2.556	1.143	
12	3974	231	.1929	54	.2045	133	2.2950	508	.1091	112	3.4681	395	2.756	1.143	
13	4482	254	.2041	54	.2440	144	2.3065	525	.1070	106	3.5784	452	2.977	1.107	
14	5041	280	.2150	54	.2845	155	2.5085	621	.0699	106	3.6814	515	3.239	1.091	
15	5662	310	.2256	53	.3406	165	2.6326	693	.0488	102	3.7956	591	3.898	1.076	
16	6354	346	.2356	51	.3996	175	2.7712	778	.0094	100	3.9353	679	4.078	1.061	
17	7132	441	.2554	48	.4675	185	2.9269	882	.0092	99	4.0922	785	4.282	1.046	
18	8014	504	.2654	47	.5464	195	3.0392	1007	.9702	94	4.2749	911	4.516	1.032	
19	9021	581	.2648	47	.6373	205	3.3047	1163	.9518	92	4.4891	1071	5.789	1.020	
20	10183	679	.2740	46	.7443	212	3.5373	1359	.9390	90	4.7429	1269	6.109	1.008	
21	11542	804	.2917	44	.8714	223	3.8090	1609	.9164	88	5.0472	1522	6.488	996	
22	13151	968	.3003	42	1.0285	223	4.1308	1927	.8994	84	5.4177	1853	6.946	954	
23	15087	1186	.3186	41	1.4379	1147	4.5183	2379	.8662	80	5.8765	2294	7.452	911	
24	17466	1496	.3168	41	1.7289	1456	5.3925	2993	.8662	80	6.4587	3802	8.020	964	
25	20458	1941	.3249	40	2.1090	1901	6.3690	3882	.8501	79	7.2191	5163	8.745	954	
26	24339	2578	.3249	39	2.6251	3086	7.4172	5241	.8344	77	8.2516	7394	9.108	956	
27	29578	3275	.3405	38	3.3643	3096	8.9114	7471	.8160	76	9.7303	1041	10.189	936	
28	37047	3860	.3480	37	4.5080	3103	11.2146	1516	.8039	75	12.0184	2010	11.769	920	
29	48661	41040	.3555	36	5.6086	3103	15.2164	2093	.8039	75	16.0204	3851	28.320	913	
30	61846	52544	.3555	35	6.5086	3120	21.0164	4398	.8039	75	24.7906	17242	49.755	906	
31	75111	59157	.3628	37	10.8925	3120	24.0164	5164	.8039	72	25.2352	59309	69.755	906	
32	88284	66190	.3700	36	28.1233	3133	27.3044	7397	.8039	72	29.7009	17242	69.755	906	

TABLE No. XXVI.

SLOPE 2 TO 1.

Degrees	Greater and lesser areas.						Horizontal distances.						Side distances.			
	A	$\frac{1}{2}$ Dif.	a	$\frac{1}{2}$ a	A—a	$\frac{1}{2}$ dif.	Y	$\frac{1}{2}$ Dif.	$\frac{1}{2}$ y	$\frac{1}{2}$ Dif.	$\frac{1}{2}$ Y+y	$\frac{1}{2}$ Dif.	Degrees.	Greater-Less-er.	Degrees.	
1	-0362	195	-0337	158	-0025	37	2.0723	380	1.9325	315	4.0048	74	2.073	1.933	1	
2	.0751	210	0.653	1.48	.0098	62	2.1502	420	1.8694	325	4.0196	125	2.151	1.870	2	
3	-1.171	228	-1.227	1.39	-0.222	89	2.2342	455	1.8103	227	4.0445	177	2.237	1.813	3	
4	-1.626	948	-1.489	1.21	-0.399	117	2.3282	495	1.7546	202	4.0798	233	2.331	1.759	4	
5	-2.121	270	-1.757	1.24	-0.632	146	2.4241	541	1.7022	248	4.1263	293	2.433	1.709	5	
6	-2.661	297	-1.972	1.18	-0.924	180	2.6510	635	1.6057	225	4.2567	359	2.656	1.662	6	
7	-3.255	328	-2.194	1.11	-1.716	217	2.7819	727	1.5612	222	4.3431	432	2.671	1.618	7	
8	-3.910	363	-2.406	1.06	-2.230	257	2.9272	811	1.5189	211	4.4461	515	2.809	1.577	8	
9	-4.636	406	-2.607	1.01	-2.940	305	3.0894	913	1.4786	192	4.5680	610	3.137	1.501	10	
10	-5.447	456	-2.739	.96	-3.561	361	3.2719	1035	1.4401	182	4.7120	720	3.333	1.467	11	
11	-6.360	517	-2.963	.92	-4.211	425	3.4788	1183	1.4034	163	4.8822	851	3.556	1.435	12	
12	-7.394	592	-3.159	.88	-5.118	504	3.7154	1183	1.3682	175	5.0827	1008	3.813	1.404	13	
13	-8.577	684	-3.327	.84	-6.618	600	3.9890	1368	1.3346	168	5.3236	1200	4.111	1.375	14	
14	-9.945	800	-3.489	.81	-8056	719	4.3090	1600	1.3022	162	5.6112	1438	4.461	1.348	15	
15	1.1545	950	3.615	.78	-9739	872	4.6888	1899	1.2711	155	5.9569	1744	4.878	1.322	16	
16	1.3444	-1146	3.794	.75	-1071	51470	-2291	1.2411	150	-	-2141	5.382	1.298	17		
17	1.5725	-1410	3.929	.73	-1.1941	1338	57110	-2820	1.2122	144	6.3881	-2076	6.006	1.275	18	
18	1.8553	-1780	4.078	.70	-1.4616	1710	3559	-3559	1.2122	139	6.9232	-3420	6.792	1.253	19	
19	2.2114	-2318	4.213	.68	-2.2537	2251	6.4228	4636	1.1844	139	7.6072	-4582	7.821	1.232	20	
20	2.6750	-3147	4.343	.65	-2.8700	3082	8.6087	6304	1.1576	130	8.5075	-6163	9.221	1.212	21	
21	3.3043	-4520	4.469	.63	-3.7614	4157	10.4065	9039	1.1314	126	9.7401	-8013	11.234	1.193	22	
22	4.2083	-7048	4.592	.60	-5.1587	6087	13.2355	14.0095	1.0817	122	11.5227	1.3973	11.234	1.175	23	
23	5.6175	-1.2530	4.591	.60	-7.6527	1.2470	18.2475	2.5060	1.0817	118	14.3172	2.4942	14.378	1.158	24	
24	8.1237	2.8511	-4.710	.58	-8.2453	5.7021	1.0560	15.1930	1.0349	115	19.973	5.6906	19.973	1.142	25	
25	13.8295	-4.826	5.3433	.56	-29.6517	25.8192	1.0349	30.6866	1.0124	112	32.715	1.0124	32.715	1.142	26	
26	39.6450	[12.9096]	-4.938	.56	-39.1512	[12.9040]	81.2800	[1.0124]	82.3024	[112]	[25.8079]	[.00437]	[1.0124]	[25.8079]	[1.142	[26]

REPORT OF THE PHILADELPHIA AND READING RAILROAD COMPANY.  
*To the Stockholders of the Philadelphia and Reading Railroad Company.*

The finances of the company at the commencement of the last year were in a state of great embarrassment.

The first object of the managers was to raise a moderate sum of money, on a temporary loan, to discharge a per centage of the pressing claims on the company, and to pay cash for expenses and further construction. This was done. The credit of the company was sensibly improved, and large reductions were made in the prices of wages, and of materials used on the road.

Owing to the fact that the shipments of coal had usually been discontinued about the 1st of December, and not resumed until about the 1st of April following, the quantity of coal transported in the months of January and February was small. In March a material improvement took place, and in April the trade was only limited by the engines and cars, want of additional track and turnouts, and the wharf accommodation then possessed by the company.

To provide these additional facilities for the increasing transportation, to repay the temporary loan, and to continue the gradual discharge of pressing claims on the company, a loan to the amount of \$500,000 was obtained in May last, on an issue of bonds secured by a mortgage, as authorized by the stockholders 10th of June, 1836.

In July, owing to the additional machinery on the road, and the greater efficiency of the track and wharves, the coal traffic was still further increased, and since then has been rapidly enlarged, as the annexed statement of transportation receipts will show.

Accompanying this is a report of the superintendant of transportation, giving statements of the various expenditures in his department; and also a report of the engineer of the road, of the expense of repairs of track, bridges, etc., and its present good condition, both of which exhibit a very satisfactory state of efficiency of the road and of its moving power.

The experience of last year's operation on the road having so entirely confirmed the opinion of the importance of an entire double track, and an extension of the wharves at Richmond, a successful effort has been made to accomplish this object by the negotiation of a loan to raise the sum of one million of dollars, for which the managers have agreed to give the bonds of the company, secured by a new mortgage, to be made payable in 1860; interest at six per cent. per annum, and convertible into stock at the option of the holder. Measures have been taken to complete the work at the earliest possible period. When this is done, and an additional number of cars and engines, which are also to be provided, are placed on the road, this great work will be powerfully effective and capable of doing a largely increased business: and it gives me pleasure to add, that I have found a strong desire among the dealers in coal, produce and merchandize, to avail themselves of the use of the road, if extended facilities are given them for transportation.

In the month of March last, a temporary mortgage as collateral security, was executed to cover the amount of \$212,635, which will be due in June, 1845, for the 450 coal cars and 12 locomotive engines furnished.

When the loan of May last was agreed on, it was deemed expedient and proper by the managers to increase that mortgage to an amount which would raise such further means as might be required to settle or pay off still more of the floating debt, and enable the company to make such further improvements on the road as were needed; accordingly, the mortgage was executed to cover the issue of two hundred and twenty-five thousand pounds sterling

bonds, and six hundred thousand dollars of dollar bonds, payable in 1860, with interest at six per cent., and convertible into stock at the option of the holder. Of these, there has been issued for sales and as collaterals,

Of sterling bonds,	£157,000
Of dollar bonds,	\$251,500

leaving now on hand, in possession of the treasurer, £68,000 of sterling bonds, and \$348,500 of dollar bonds, for any purposes which may be required.

I submit herewith a statement of the liabilities of the company made by S. Bradford, Esq., secretary and treasurer, which, having increased materially over that of last year, calls for the following explanations.

The critical position of the company in 1842, and the unfinished state of the road, obliged the managers then to raise money at great sacrifices, for which bonds have been issued the past year, according to their agreement.

The improvements on the road, and general extension of its capacity and moving power, which has been going on through the whole of the past year, have necessarily materially increased the items of "construction account," and "locomotive engines and cars."

The still large amount of "notes payable," notwithstanding the very considerable sum paid this year in cash, is accounted for by a large portion of the judgments represented in last year's ballance sheet and part of the loan due in 1843, being this year merged into "notes payable," and by numerous settlements with contractors, and for land damages, etc., which, till this year, it has not been in the power of the company to make an adjustment of, now largely reduced.

The "bonds and mortgages on real estate" existed previous to the last year. To represent the true cost of this property, the amount is now charged on "real estate" account.

The "drafts payable" have been reduced from \$102,170, on December 1, 1842, to \$26,955, December 1, 1843, which will soon be liquidated.

I have to state that a settlement was effected in April last of the large debt to the trustees of the bank of the United States, at a gain to the company, of \$75,000.

The officers and agents of the company in their respective departments, have fulfilled their duties in a manner which has been gratifying to me, and I trust that the general management of this important work the past year, during which it has been raised from a position of great depression, to its present effective state, will meet the approval of those interested in it.

Very respectfully,

January 3, 1844.

JOHN CRYDER, President.

---

*To the President and Board of Managers of the Philadelphia and Reading Railroad Company.*

GENTLEMEN—The following report of the operations on the road, during the eleven months ending November, 30th, of the present year, of its business and its machinery, is respectfully submitted.

The business of the road in its most important feature, the transportation of coal, has been almost wholly dependant upon, and proportioned to, the increase of track facilities, and of machinery, engines and cars, furnished for that purpose, during the present year.

In the last report of the general superintendent, of December 31st, 1842, there were on the road, at that date, 1130 coal cars, and 16 coal engines; these numbers have been increased to 1592 coal cars, during the months of May and June of this year, and to 30 locomotive engines, adapted to hauling coal, between the months of June and September, 1843.

Statement A will show in detail the force of machinery at present on the road.

The quantity of coal hauled over the road to June 30th, before the machinery had been increased to its present force, and the track and wharves made more effective, amounted to 62,099 tons; since which time, to the present date, a period of five months, the coal tonnage has risen to 156,612 tons, making a total of 218,711 tons of coal transported to market during the eleven calendar months ending November 30th, 1843.

The efficiency of the road in passing, with expedition and safety, coal, freight and passenger trains, moving in opposite directions, has been very materially increased by the completion, in July last, of 10 miles of double track, extending from Baumstown to one mile above Reading.

Statement C exhibits in detail the expenses of the transportation department of the road, and statement D, the apportionment of these expenses to the several items of business on the road—coal, freight and passengers.

It will be observed, from the latter statement, that the actual cost of hauling coal from the mines to the Delaware, including returning the empty cars has been, during the year, but 46 cents per ton. This has been much higher than may be calculated on for the future, for the following reasons:

1st. The inferior quality of construction of most of the coal cars built for the company, owing, in a great measure, to the haste with which they were constructed, causing an unnecessary frequency of accident from breaking axles, etc., and a serious increase in their repairs.

2d. The comparatively small and uncertain business done in the early part of the year, which consequently increased the cost of carriage per ton, from engines failing to obtain trains from either end of the line, and running in some cases with loads below their allotted compliments.

3d. From the expense, direct and indirect, attending the employment of 12 new engines, built by the Locks and Canals Co., each of these being placed in the heavy business of the road, immediately on being put together, and, on several occasions, failing when on duty, from defective arrangements, and quality of some of the lighter gearing.

4th. From the short period, (the last three months only,) during which there has been employed a new system of working the road, by which the maximum effect of all its machinery and track facilities was obtained, with an evident economy resulting.

5th. The greater proportion of light six wheeled engines, in the first six months of the year, compared with the whole number in the latter part; the former hauling lighter trains, and consequently increasing the cost per ton of coal.

Lastly. The greater experience gained by the year's working of the road and its machinery, pointing out where improvements or alterations may be made with advantage and economy, in either the general features or minute details of the important work under your direction.

From the above considerations, it is confidently believed that the cost of hauling coal per ton, during the ensuing year, 1844, will not exceed 40 cents.

On a comparison, it is found that the receipts from passengers for the present year, amount to but 77 per cent. of those of 1842. This falling off, however, has been materially checked by a reduction of the rates of fare, which took place on July 24th last, since which date the receipts have increased to 89 per cent. of the same period last year; having been previous to that date only 69 per cent. of the receipts of that year.

The passenger fares now charged are \$2 50 and \$2 00 for the 93 miles.

A still greater increase of passenger travel and receipts may be confidently anticipated during the ensuing year, and for the future, when the low rates of fare now charged shall have become more extensively known and circulated.

Alterations are now making on some of the light four wheeled passenger engines, which will increase their speed by some three or four miles an hour at a trifling expense; which, when effected, will allow a more favorable comparison with other well constructed roads in speed of passenger trains—an important object to this road.

It may be stated, as a gratifying fact, that notwithstanding the very heavy amount of tonnage passed over the road during the past eleven months, 56,554 passengers have been transported without the slightest personal injury to any one.

By reference to statement A, it will be seen that the company own at present 39 locomotive engines, built by the following makers:

8	passenger and light freight engines, made by Braithwait & Millner, London.
12	coal engines, made by Locks and Canals Co., Lowell.
3	" Eastwick & Harrison, Philadelphia.
2	" Wm. Norris, Philadelphia.
5	" Newcastle Manufacturing Co., Newcastle, Del.
2	" Dotterer & Co., Reading, Pa.
6 light "	M. W. Baldwin, Philadelphia.
1	four wheeled with vertical boiler to burn coal, made by Ross Winans, Baltimore.

39

All of which are at this date in good running order, or undergoing such light repairs as to be ready for service on the road at two days notice, with the exception of one of the new engines, now altering with a view of fully testing the use of anthracite coal for fuel.

Convenience and economy will both render the successful result of this experiment most desirable, although several previous attempts to burn this fuel with advantage have been attended with an expense and inconvenience which, in some cases, deranged the business of the road.

The undersigned is aware of the importance of introducing this fuel upon a road which depends mainly upon the coal trade and the coal region for its support; but has been unwilling to expose the road, while working smoothly and passing a heavy business over its single track, to that inconvenience which has hitherto in most cases, on this as well as other roads, attended such experiments.

It is hoped and believed that the attempt will eventually succeed, and all that skill, experience and ingenuity can suggest, will be done to effect this most desirable object.

The tonnage of the last eleven months on the Reading railroad, with all the disadvantages of a want of sufficient machinery early in the season, already exceeds that of any double or single track railroad in the country, and it is believed, that of any single track railroad in the world.

It amounts, as per statement B, to 317,277 tons.

Although material reductions will be made, as before stated, in many items of the expenses of the road, for the coming year, the undersigned may yet solicit a comparison of the expenses of the department entrusted to his charge, with those of other railroads, considered the best and most economically managed in the eastern States.

It will be found that the average expense of ten of the most important of these railroads is six per cent. per mile over that of the Reading railroad, while that of only *three* is less—each with a tonnage supposed not more than one-tenth of that of this road.

The average weight of loaded coal trains down the road during the past eleven months, including the cars, has been 299 tons, equal to  $49\frac{1}{2}$  cars loaded with  $3\frac{1}{2}$  tons of coal each, or a nett weight of 161.8 tons (2240 lbs.) of coal to each train. The average weight of empty coal trains up the road, for the same period, has been 121 tons, equal to  $50\frac{1}{2}$  empty coal cars of 2 tons 2 cwt. each.

The gross expenses of the transportation department of the road are exhibited in detail in statement C. It is proper to state, that some portion of these expenses were necessarily larger on the commencement of a business of such magnitude, without the required facilities for carrying it on—such as turn-outs, track room, machinery and workshops, and supply of water to water stations. A very considerable portion also of these expenses may be considered permanent, and are but slightly increased by a business double or treble that hitherto done on the road. Among the latter expenses may be enumerated the repairs of road-way, salaries of officers and agents, stationery and printing, hauling across Schuylkill bridge, wages of watchmen, coal for offices and stations, wages of depot hands, in part, materials for depots, water rents, etc.

The experience gained by those in charge of the several departments of the road, will prove most valuable to its business for the future in decreasing its expenses and adding to its facilities.

The expenses for the coming year will show a considerable saving in several important items, which may here be alluded to. All the brass castings and coppersmith work of the line are now done at the company's workshops at Reading, under the superintendance of the foreman, of a much better quality than were before purchased elsewhere, and with a saving of two-fifths of the expense.

Babbit's patent friction metal has been introduced very successfully into all the running gearing of the engines, as well as the car boxes, with a saving of friction, oil and wear and tear. Ray's patent spring is now used altogether on the road, with a saving of one-fourth in weight and expense.

A considerable proportion of the repairs of coal cars was on account of axles, mostly of inferior quality, breaking on the road. An arrangement has been made with an eminent manufacturer of these important articles, by which axles of a most superior quality are furnished at a trifling advance upon those which have proved defective, with which the latter are replaced when found necessary.

It is believed that great advantages will result to the road by using sheet iron coal cars, one of which is now building by the company. It will weigh but  $2\frac{1}{4}$  tons, will carry 5 tons of coal, will last much longer, cost less for repairs, and diminish the cost for carrying coal about 20 per cent., by the greater proportion of useful to useless weight.

An economy is also anticipated in the use of steel axle journals and chilled cast iron boxes, in the coal cars, by diminishing friction and the quantity of grease required.

On reference to statements C and D, of the expenses of the road, it will be seen that the sum paid the State for tolls and motive power, over the  $3\frac{1}{2}$  miles of their road, during the past eleven months, amounted to \$12,384 57. To this must be added the expenses of hauling across the Schuylkill bridge, and extra conductors, watchmen, etc., making a total of \$13,670 07 for the eleven months, or \$14,912 80 per annum.

The cost of conveying a passenger from Pottsville to the junction with the State railroad,  $89\frac{1}{2}$  miles, has been, during the past year,  $38\frac{7}{8}$  cents, including pay of engineer conductor, fireman, fuel, tallow, water, oil, repairs of engine, tender and cars.

The amount paid to the State on each of these same passengers, for use of the  $3\frac{1}{4}$  miles of their road and motive power *above*, is  $13\frac{1}{2}$  cents, besides the cost of hauling across the Schuylkill bridge.

The cost of hauling coal over this road, from the junction of the Reading railroad to Philadelphia, not including repairs of cars, is  $14\frac{1}{4}$  cts. per ton.

In conclusion, it may be confidently stated, that the future prospects and value of the noble improvement under your management is most encouraging.

It stretches from the most extensive anthracite coal region in the United States, to its second city in population and importance.

The supply of the material constituting its chief dependence for tonnage is inexhaustible, and is mined by a hardy, enterprising and rapidly increasing population, and can pass to the Philadelphia market by no shorter or more direct route than the Reading railroad.

In the carriage of its coal to tide water, it is assisted by the power of gravity overacting in the required direction of the descending trade, through a fall of 590 feet, and so spread over the 94 miles, that the power of the engine in taking back its empty train, is no more taxed than when hauling the previous train loaded over a level.

The length of the road allows neither more or less than one good day's work per trip of 94 miles to all hands employed on the train, and therefore secures a *maximum of economy* in the item of men's wages.

The article carried cannot be stolen, lost or destroyed; and even in cases of accident, it is taken and used by the company at cost price.

The valley of the Schuylkill, through which this railroad passes, is one of the richest in the State in fertility of soil, mineral and agricultural productions. Iron in every stage, from the ore to the bar, lime stone, grain, flour and all the produce of the farm and the forest, are within reach along its whole route, and, with the accompanying travel, contribute to its revenue.

Its ability to command and transport the whole of this trade will go on increasing, since every year presents new improvements in the management and machinery of railroads, tending to their economy and efficiency.

All which is respectfully submitted, by your obedient servant,

G. A. NICOLLS,

*Sup. trans. mot. power and machinery Phil. Read. and Potts. railroad.  
Reading, Pa., Nov. 30, 1843.*

#### STATEMENT A.

*Amount of running machinery on the Philadelphia, Reading and Pottsville railroad, November 30th, 1843.*

23	8 wheeled engines, from 11 to 13 3-4 tons.	1592	4 wheeled coal cars.
7 6	" " 10 1-2 to 12 1-2 "	12	8 wheeled passenger cars.
8 4	" " all 8 4-10 "	2 4	" "
1 4	" for use of anthr. coal, wt. 10-43.	6 4	" baggage "
39	in all. Above weights in running order.	20	in all.
189	4 wheeled truck freight cars.		Engines and cars contracted for, not yet delivered—1 locomotive engine, of the heaviest class, for Falls grade, from Newcastle Manufacturing co; 24 open freight car truck bodies to be mounted as covered cars.
1 8	" " "		
16 4	" covered, "		
2 8	" " "		
208	in all.		

#### STATEMENT B.

*Of amount of business on the Philadelphia, Reading and Pottsville railroad, for the first eleven months of 1843.*

Total amount of coal transported in tons of 2240 lbs.,	218,711
" mdze. " " 2000 "	17,534
" tonnage for use road, earth, rails, stone, sills, pipes etc. 2000 lbs.,	54,787
Total tonnage of road, in tons of 2000 lbs.,	317,277

Total number of passengers transported,	56,554
" " miles travelled by the same,	2,457,439
Equal to, in through passengers over whole length of road,	26,424
Gross receipts from passenger travel,	\$71,895 21
" " freight on merchandize,	37,926 57
" " coal,	278,840 20
" " transportation of United States mail,	5,500 00
" " all other sources,	156 51
	\$394,318 49
Deduct debts outstanding, due company, Nov. 30th, 1843,	9,123 10
Nett receipts of road for 11 months,	\$385,195 39

## STATEMENT C.

*Gross expenses of the transportation department for the first eleven months of 1843.*

## RUNNING ACCOUNT.

Wages of engineers, conductors, breakmen, etc.,	34,449 21
Fuel, 15,554 5-8 cords wood,	36,182 44
Oil, 5,796 1-2 gallons,	4,375 81
Tallow and lard,	2,008 72
Columbia railroad expenses, amount paid State,	12,384 57
" " hauling across Schuylkill bridge,	1,010 00
Hauling cars in Broad street,	884 84
Loading and unloading wood and freight,	2,221 85
Renewals of articles for coal trains, ropes, lamps, etc.,	1,108 64
Cotton waste,	364 15
Goods damaged, stolen or lost,	103 13
Coal broken on road, and used by company,	698 28
Sundry small items,	1,227 73— 97,029 37

## WORKSHOP ACCOUNT.—[See statement E and F.]

Wages of mechanics, at repairs, engines, cars, etc.,	23,058 05
Bar iron, steel and other materials for do.,	9,828 68
Iron and brass castings, and copper work,	2,443 08
Timber for repairs, engines and cars,	1,600 73
Coal for stationary engine and smith's fires,	786 44
Sundry small items,	566 51— 38,283 49

## DEPOT ACCOUNT.

Wages of depot hands, pumping water (\$4,460.) watchmen, etc.	18,650 38
(\$1,804 50.) cutting wood, tending freight, etc.,	1,333 51
Bills of cutting wood,	610 06
Coal for water stations and offices, 148 1-2 tons,	255 00
Water rents,	324 73
Taxes on property and real estate,	607 97— 21,781 65
Sundry small items, materials, etc.,	

## OFFICE AND SUPERINTENDANCE ACCOUNT.

Printing, advertising, stationary, furniture, articles for offices, & rent,	2,114 94
Fees of magistrates, law expenses, etc.,	154 92
Salaries of all officers, agents, and clerks in department,	12,269 36— 14,539 28

Gross expenses of department for 11 months, \$171,633 73

## STATEMENT D.

*Nett or actual expenses of the first eleven months of the year 1843.*

Transportation of 218,711 tons of coal, from Pottsville and Schuylkill Haven to Richmond, on the Delaware, and to junction with State road, at 46 cts.,	\$100,607 06
Transportation of 26,424 passengers to junction State road at 38 7-10ths cts.,	10,226 09
Transportation of 17,534 tons merchandize, between Pottsville, Reading and other points, and State road, at 66 1-2 cents,	11,660 11
Transportation of sundry materials for use of road, including 40,484 tons of earth, 1,274 tons rails and iron for track, 8,031 tons sills and stone, 56 tons pipe, and sundries, amounting to 54,787 tons, at 5 cents,	2,799 35
Superintendance and salaries of all officers, agents and clerks, and coal agents at depots,	13,790 61
Expenses on Columbia railroad and in Broad street,	14,471 91
Wages of watchmen at depots,	1,804 50
Sundry repairs to, and materials furnished depots,	1,198 42
Making patterns, tools and sundries at workshops,	1,500 51
Over,	\$157,995 56

*Cost of Transportation on Canals.*

	Brought up,	\$157,995 56
Additions and alterations of locomotive engines, as sand boxes, waterpipes, etc.,	962 52	
Alterations and additions to Reading workshops,	495 40	
Making and fitting up machinery for do.,	559 93	
Building and altering four wheeled into six wheeled tenders,	1,278 97	
Office exp's, printing, stationary, advertising, furniture, coal, rents, materials, etc.,	2,619 08	
All other expenses not enumerated, taxes, etc.,	634 84	

Actual nett expenses, - \$164,549 30

Add for materials on hand as follows:

Wood,	\$3,774 40
Iron, cast and wrought, and steel,	1,120 00
Iron and steel, made up,	987 33
Wheels and axles,	234 26
Engine and car fires,	370 53
Copper work, made up,	353 33
Brass, lead, etc.,	701 15
Bituminous coal,	200 00
Timber and lumber,	343 33

Gross expenses, - \$171,633 73

## STATEMENT E.

*Repairs of locomotives, for the first eleven months of 1843.*

Cost of all materials used, iron, steel, brass, etc.,	\$2,208 71
Wages of mechanics,	9,804 90
Superintendance, oil, tools, paints, etc.,	1,210 62
Equal to 4 2-10 cents for each ton of 2000 lbs.,	\$13,224 23

## DETAILS OF WORKING OF ABOVE ENGINES.

Total number of miles run by heavy coal and freight engines,	313,392
Total number of miles run by light 4 wheeled passenger engines,	79,800
Total number miles run,	393,192
do. do. tons hauled one mile,	59,797,126
Average gross weight of loaded coal trains down the road, exclusive of engine and tender, in tons,	299
Average gross weight of empty coal trains, up the road, as above,	121
Average gross weight of passenger trains, in tons,	26
Quantity of sperm oil used by coal engines and tenders, per trips of 90 miles with above trains, in quarts,	399
Quantity of sperm oil used by passenger train engines, per trips of 90 miles in qts.,	269
Total number trips of passenger trains,	667

## STATEMENT F.

*Repairs, and working of coal, freight and passenger cars, during the first eleven months of 1843.*

## COAL AND FREIGHT CARS.

Cost of all materials, iron, steel, brass, etc.,	\$2,617 12
" timber and lumber,	1,386 89
Wages of mechanics,	9,013 55
Superintendance, oil, tools, paint, etc.,	1,301 74
Total cost,	\$14,319 30

Or 4 1-2 cents per ton of 2000 lbs.

Number gallons oil used by freight and coal cars,	1,520
do. lbs. tallow do. do.	29,133

## PASSENGER CARS.

Cost of all iron, timber and materials,	\$243 28
Wages of mechanics,	559 16
Sundry charges, glass, paint, varnish, etc.,	100 30
Total cost,	\$902 74
Equal to 3 cents per each through passenger.	

Number gallons oil used by passenger cars,	25
Number pounds tallow used by do.	1,052

For the American Railroad Journal and Mechanics' Magazine.

COST OF TRANSPORTATION ON CANALS. BY W. R. CASEY, CIVIL ENGINEER.

The great object of canals and railways is to reduce the cost of transportation to the lowest practicable limits which yield a reasonable income on

the capital invested in their construction. A correct understanding of the rates of toll requisite to insure this fair return is, therefore, of vital importance. It is not strange that great difference of opinion should prevail as to the cost of transportation on railways, for the only road in the country built for the accommodation of a large business in freight, has been but a few months in full operation. Still its friends and foes have ventured to prophecy its success and ruin with the utmost confidence.

It is however strange that an equal difference of opinion prevails as to the cost of transportation on canals. The president of the Schuylkill navigation company states,

"In the past season the whole charge for carrying coal upon the Schuylkill navigation, including freight and toll, has been less than one cent and a quarter per ton per mile, and it may be materially reduced hereafter."

From this we may conclude that he looks forward to a total charge of one cent per ton per mile, the toll being one-half cent per ton per mile. At this rate the Erie canal would be a complete failure, and the Delaware and Hudson canal requires eight mills per ton per mile, nett profit, to pay a reasonable dividend. The Schuylkill canal must, therefore, have advantages of which we in New York know nothing, having always considered the Erie canal as not only unsurpassed but unrivalled by any similar work in its favorable location, small cost, moderate lockage, immense business, and, more than all, its rigorous monopoly.

The Erie canal is 363 miles long, has 698 feet lockage, cost to this time at least \$10,000,000; ordinary expenses about \$1,000 per mile per annum, and with extraordinary repairs and renewals about \$500,000 per annum.

In 1840, there moved on the canal 829,960 tons, the income was (less \$58,458 87 for passengers) \$1,478,141 62=\$1.781 per ton. The average movement in 1839 was determined with precision, and was 154 miles. The freight that year was 848,007 tons. (Assembly doc. 1840, No. 306, p. 38.) Now \$1.781+154=\$0.0115 per mile per ton of 2000 lbs.=0.1288 per 2240 lbs. per mile=more than 150 per cent. advance on the charges of the Schuylkill canal.

$$\text{Again, } 829,960 \times \frac{154}{2} = \$639,069.20$$

Less ordinary expenses,	363
-------------------------	-----

Leaving for renewals and interest,	\$276,069.20
------------------------------------	--------------

or  $\frac{2}{3}$  per cent. on the low estimate of \$10,000,000. This is however taking the ton at 2000 lbs., but the reader will probably consider the "reductio ad absurdum" carried far enough.

In the elaborate report above alluded to, in which every thing connected with the Erie canal is tinted "couleur de rose," it is said, (p. 39,) "

"The actual cost of transporting a ton on the present canal, including every species of expense, except tolls to the State, is, on the average, nine mills per mile."

It is not stated whether this includes the profits of the forwarder, but it is less than the average charge of last year, which was at least  $11\frac{1}{4}$  mills per

mile per 2240 lbs. for flour, the favorite cheap down freight on the Erie canal. But, neglecting this, we have cost of transportation,

$$\begin{array}{l} \text{009 } \\ \text{add toll, } \\ \text{0115 } \end{array} \left\{ \begin{array}{l} = \text{ } .0205 \text{ per 2000 lbs per mile, total average} \\ \text{charge at this time.} \end{array} \right.$$

The 25 or 30 millions to be expended in the enlargement will, as its friends "fondly hope," reduce the cost of transportation one-half;

$$\begin{array}{l} \text{that is to } \\ \text{add toll, } \\ \text{0045 } \\ \text{0115 } \end{array} \left\{ \begin{array}{l} = \text{ } .0160 \text{ per ton of 2000 lbs. per mile,} \\ \text{or } .01792 \text{ per ton of 2240 lbs.} \end{array} \right.$$

This is the lowest estimate of the most sanguine friends of canals in this State, it anticipates an increase of business boundless as the west, and a firm continuance of the State monopoly.

The Delaware and Hudson canal is 108 miles long, and brought down in 1842, 205,253 tons of coal, at a cost of \$274,020 46, exclusive of toll. This is at the rate of \$1.335 per ton of (I suppose) 2240 lbs., or .01234 per ton per mile. The statement of the company is annexed, and it will be seen that they receive very nearly 2½ cents per ton per mile for the entire distance of 108 miles of canal, and 16 miles of railway. The "nett profit of the year is \$196,051 51, being over ten per cent. on the capital stock of the company." The cost of the works is not given, but as they owe the State \$800,000, on which they pay a low rate of interest, it must be about \$2,600,000, so that the Delaware and Hudson canal pays 7½ per cent. on its cost, at the above rates and with the above business

#### *Statement of the expenses of the Delaware and Hudson Canal Co. for 1842.*

To coal on hand, 1st March,	\$104,870 00	By sales of coal,	\$781,169 87
" Mining coal,	107,683 99	" Canal and railroad tolls,	33,894 93
" Railroad transportation and repairs,	115,755 85	" Interest received,	23,845 74
" Freight of coal to Rondout,	274,020 46	" Coal on hand,	124,691 50
" Capital repairs and superintendance,	77,078 91		
" Labor and expenses at Rondout,	21,793 69		
" Interest on State stock,	28,500 00		
" Company loan,	4,620 00		
" Salaries, current expenses, rents, etc.,	23,227 63		
Balance,	196,051 51		
	\$963,602 04		\$963,602 04
March 1, 1843.		By balance,	\$196,051 51

Flour has been for many years carried from Albany to New York for 12½ cents per barrel, or 8½ mills per ton per mile. It is now carried for 10 cents, or 7 mills per ton per mile. Were the distance reduced from 150 to 108 miles, the cost could scarcely be less than 7½ mills, or 50 per cent. more than the forwarders on the Schuylkill canal are to receive according to Mr. S. W. Roberts, the president of the Schuylkill navigation company, and, I presume, the well known engineer of that name. On the Hudson they have also a vast quantity of up freight paying one to two cents per ton per mile; besides crowds of emigrants.

I confess my inability to comprehend that the Schuylkill canal should in any way rival the Hudson—as for exceeding it, a highly respectable miracle will be required to enable me even to entertain the proposition. It will be fortunate indeed if the present rivalry between *the* canal and *the* railway does not terminate in a case more appropriately falling within the jurisdic-

tion of the patron saint of Pennsylvania—the Rev. Sidney Smith—than within the province of the engineer.

A variety of minor considerations may be advanced which would make the case of the Schuylkill canal appear a little better; the same may be said, and to a greater extent, of the Erie canal. To these I may allude in another number of the Journal.

*New York March, 1844.*

---

REPORT OF THE SCHUYLKILL NAVIGATION COMPANY TO THE STOCKHOLDERS.  
(Continued from page 51.)

Originally a depth of three feet was aimed at, in constructing the canals and pools; but has since been increased to four feet, and, in many places, to much more; but the shallowest parts must of course limit the capacity of the navigation. During the past season, the levels have been kept full, and one boat, No. 169, called the "President," came down, drawing 49 inches of water, and carrying 71 tons, 9 cwt. of coal.

In these days of keen competition in the coal trade, it is a matter of great interest to reduce the freights as much as possible, and this may most easily be effected by increasing the loads. An enlargement of the canals and of the locks would be attended with great expense, and would require boats of different dimensions from those now in use. The question of accomplishing the same end by a more simple and less expensive process, thus acquires additional importance.

It has been found by careful experiments made this season upon boats in use, that a good boat, when drawing 46 inches water, will carry 66 tons; and that every additional *half inch* displaces one ton of water, or adds one ton to the boat's capacity of carrying. So that when the boat draws seven inches more, making 53 inches, or 4 feet 5 inches, it will carry 14 tons more, making 80 tons; and, in the same proportion, a draught of 5 feet 3 inches, will carry 100 tons, which has been verified by actual experiment with the boat "Wm. P. Cox," No. 472, which, having brought 64 tons of coal to Philadelphia, was loaded to 100 tons, with the above draught of water, and carried her cargo to New York.

Seventy cents per ton is found to be a fair price for freight from Pottsville to Philadelphia, with a boat carrying 60 tons and a steady trade. Suppose the shallow parts of the navigation to be deepened a few inches, and the boat thus enabled to carry 80 tons. This gives an addition of one-third to the tonnage, and reduces the freight per ton in nearly a corresponding proportion, for the boat requires no more force to manage it. Another advantage is a diminution of the number of lockages, and consequent economy of water for a given amount of freight. The same reasoning will apply to a greater increase of depth and tonnage, and it will no doubt ultimately be accomplished; but the mark of 80 tons seems to be attainable without any large expenditure, and with many of the boats now upon the line; and any increase in the column of water, in the shallow parts of the canal, will be an advantage to every boat, by diminishing the resistance to its motion.

With a view to obtain correct information in reference to the subject of deepening the navigation, the managers have directed the line to be examined and sounded throughout its length, which is now in progress.

In the past season, the whole charge for carrying coal upon the Schuylkill navigation, including freight and toll, has been less than one cent and a quarter per ton per mile, and it may be materially reduced hereafter.

Let us now compare this charge with the expense of railway transporta-

tion as ascertained from the experience of a series of years, in England, where wages, fuel and iron are cheap, and where there is intense competition between the different coal districts.

An eminent English engineer, by whom several important railways have been constructed, Charles B. Vignoles, professor of civil engineering in the London University, has recently given to the public the following results:

"The cost of carrying coals, at very moderate velocities, on the great colliery railways, is about one penny (equal to two cents) per ton, which may be divided into the following heads, viz :

**EXPENSE OF TRANSPORT OF COAL.**

	Decimals of a penny.
Locomotive power,	·38
Wagons,	·19
Conducting traffic,	·08
Maintenance of railway,	·21
General expenses, including local taxes,	·14

Per ton of coal per mile,                                    1·00 or 2 cts.

"The proportion of the oweight of the coal to the gross load carried being as 3 to 5. The expense of carrying goods on the Liverpool and Manchester railway, taken on the average of seven years' traffic, appears to be about two and a half pence (equal to five cents) per ton per mile."

This however includes half a penny for the expense of collecting and delivering the goods.

The general results of English experience are thus tabulated; and we may remark, that they agree very nearly with the calculations of the cost of transportation on a number of American railroads, as given by Mr. C. Ellet, Jr., civil engineer, in his interesting essays on that subject.

**"EXPENSE OF RAILWAY TRANSPORT PER MILE.**

Passengers, at high velocities,	1d. (or 2 cents) each.
Coal, at very moderate speed,	1d. (or 2 cents) per ton.
Merchandise, at 15 miles an hour,	2d. (or 4 cents) per ton."

Thus the expense of carrying merchandise, at 15 miles per hour, is twice that of coal, at about 5 miles per hour; half of which difference is due to the increased velocity. So that to carry coal, at 15 miles per hour, would cost three half pence, or three cents, per ton per mile, without including anything for interest or profits. [See Mr. Vignoles' sixteenth lecture reprinted in the Journal of the Franklin Institute for December, 1843.] In another place, Mr. Vignoles has observed, that he thought the proper railway *charge* should be double the *cost* for working; which, for transportation, at 15 miles per hour, would make the charge six cents per ton per mile, or nearly five times the present charge for carrying coal upon the Schuylkill navigation.

The spendthrift and prodigal policy, sometimes pursued upon railroads, soon after their first construction, of carrying heavy freight at high velocities and at low prices, less by far than sufficient to keep up the business, soon defeats its own object, and comes to a speedy end, when the ability to accumulate indebtedness no longer exists. With the weight of the load, and the rate of the speed, the wear and tear increase in a constantly increasing ratio, until the road itself, and its costly machinery and carriages are found to be involved in a common destruction. Though this conclusion may not at first be strikingly apparent, it is just as certain as the effect of over exertion and high excitement upon the human constitution, and much more speedy in its result; for a railroad, unlike the human frame, has nothing recuperative in its nature.

Nearly one half of the Schuylkill navigation is constructed in the river, deepened and improved by art, and the gentle current being in the direction of the heavy descending grade greatly facilitates its transportation; so that the river may be considered as a moving road, the surface of which is con-

stantly renewed by the bounty of Providence, in sending the early and the latter rain.

It is usual for eminent success to induce attempts at competition, and a portion of the increasing trade of the valley of the Schuylkill may for a time be diverted from its natural channel, but your president and managers are fully convinced, that no land carriage can long compete with such a water communication in carrying freight; and, believing that a judicious and firm administration of your affairs must lead to ultimate results which will both gratify your hopes, and justify their expectations, they have deemed it due to you to embrace a wider range than usual in this annual report, so as to give in some degree the grounds of their unshaken confidence in the intrinsic value of your noble work, from which you may draw your own conclusions.

All which is respectfully submitted,

SOLomon W. ROBERTS.

*President.*

January 1, 1844.

For the American Railroad Journal and Mechanics' Magazine.

BALDWIN AND WHITNEY'S SIX DRIVER LOCOMOTIVE.

Among the numerous improvements which have of late years conspired to elevate the railroad system to the high degree of advancement by which it is at this time characterized, there is perhaps none more calculated to secure to its projectors the award of well merited praise for ingenuity—and to the public a most essential benefit in the provision of an efficient basis for the reduction of railway fares, than the six driver locomotive engine recently designed and constructed by those enterprizing machinists, Messrs. Baldwin and Whitney, of Philadelphia.

To the character for skill and perfection of workmanship, which these gentlemen have so deservedly maintained, by the construction of engines of an excellence of finish, a symmetry of proportion, and a judicious adjustment of parts, unsurpassed by those of any other manufacturers in the world, they have now added that of bold but successful innovators, in presenting us with a machine designed on principles, the application of which to railway purposes is entirely new; and which, we may confidently assert, secure to the system a motor at once more powerful, and less injurious to the road, than any other which has hitherto been introduced.

This engine may justly be regarded as revolutionizing the railway system, at least so far as relates to its application to the roads of our interior, or of other sections where the command of pecuniary resources is comparatively restricted, and where railways must necessarily either be constructed with less regard to strength than those of more wealthy sections, or not constructed at all.

The ability to avail ourselves of the total amount of adhesion due to the weight of the engine, and at the same time to introduce more than four driving wheels, in order to distribute the weight among a number of points of contact with the rails sufficient to avoid injury from either abrasion, or too great strain upon a single point, has long been considered as a desideratum of paramount importance.

For some years past, many eminent machinists have been engaged in en-

deavoring to devise means for reducing the problem to a form that should be practically available; but with the exception of the machine of Messrs. Baldwin and Whitney, their attempts must be regarded as in a great measure abortive. The efforts of these gentlemen have at last been rendered successful by means of a happy application of the principle of the ordinary parallel ruler, by which they secure the constant parallelism of all the axles, and at the same time allow the wheels to adjust themselves, to a considerable extent, to the various curvatures of the road.

The connecting rods are furnished with ball and socket joints, which admit of motion in every direction without strain.

Careful experiments made upon one of our northern railways, for the purpose of testing the comparative merits of these engines, and of others in common use, have shown conclusively that the former experience less resistance from friction upon curves than the latter, thus placing at rest one of the most formidable objections that had been advanced against the six driver engines.

A careful account was kept of these experiments, and I am pleased to learn that the results are in the hands of a member of the profession, under whose supervision they were conducted; one eminently qualified for the task, and who will probably arrange and prepare them for publication in the Railroad Journal.

When the merits of Messrs. Baldwin and Whitney's engine become more generally known, I have little doubt but that it will in a great measure supersede all others of prior construction, especially for the carriage of freight. The number of drivers is by no means limited to six, but may be increased to eight or more if required.

It would be difficult to convey a very correct idea of the details of construction which constitute the peculiarities of this engine, without the use of drawings, which I have it not in my power to furnish at this moment, but which I may prepare to accompany a more specific paper on the subject in a future number of the Journal. The more immediate object of this communication is to direct the attention of railway companies, especially those whose roads are not of the most permanent construction, to a machine eminently adapted to their purposes, inasmuch as it obviates that most formidable source of injury, and consequent expense, the too great weight borne upon each driver of the ordinary engines.

JOHN C. TRAUTWINE.

---

We have frequently heard the improved engine of Messrs. Baldwin and Whitney spoken of by experienced engineers in very favorable terms, and have made quite an effort to obtain an accurate description of it, as well as a detailed account of its performance on the western railroad last fall, but have been unsuccessful in both; yet, we hope soon to receive from the gentleman who has the minutes of these experiments, a full report of its work, in comparison with other engines worked at the same time; and we now

call on the writer of the above communication, who is familiar with the improvements, and fully competent to the task, to furnish us with a description accompanied by illustrations, of the engine; that the numerous railroad companies in this country and Europe may, through this Journal, be informed of its excellence; and the ingenious manufacturers—whose modesty appears to exceed if possible their skill as machinists—may receive a remuneration equal to their deserts; and the travelling community derive the advantage which is sure to result from reduced fares. We trust that we shall soon hear from the gentleman referred to, and also from Mr. Trautwine again.—(*Eds. Railroad Journal.*)

---

ENGINEERS' AND MECHANICS' POCKET BOOK.—BY CHARLES H. HASWELL, CHIEF  
ENGINEER, U. S. NAVY.

We cordially recommend this little work to the notice of the profession, as containing, within the same space, more information likely to be useful—and that information, too, more skillfully arranged—than any similar work with which we are acquainted. It is beautifully as well as conveniently got up, contains 264 pages of matter well condensed, with only half a dozen blank leaves at the end, in place of being little more than a memorandum book for the year, as is the case with some of the English works of this description.

The tables are numerous and elaborate, comprehending very extensive ones of weights and measures, foreign as well as domestic; of areas, squares and cubes, natural sines and tangents, specific gravity, strength of materials, flow of water through pipes, weights of bar and sheet iron per lineal and square foot, etc. We understand that many of the tables and formulas have been re-calculated by Mr. Haswell, who has spared no pains to combine accuracy with condensation—the great aim in such works.

To the civil engineer, when away from his books, it will prove an invaluable companion; and here we will venture to suggest to Mr. Haswell, that a table of natural sines and tangents to minutes, would have added materially to the value of his manual to the railway engineer, for we do not remember to have ever seen such tables in pocket form. Hassler's tables give the natural sines and cosines only, and they can hardly be called a "pocket book." A table to fifteen minutes will, however, be often useful, and perhaps it did not fall within the scope of his project, to devote a dozen pages more to this purpose. We repeat that nowhere have we seen so near an approximation to what an "Engineers' and Mechanics' Pocket Book" should be, as this little work of Mr. Haswell's.

---

RAILROAD REPORTS.

We are indebted—not to the managers, but—to a friend, for the eighth annual report, for 1843, of the directors of the Western railroad company. It came to hand too late for use in this number—but we refer to it for the purpose of saying to the managers of the various railroad companies, that we believe they would promote their own, quite as much as our interest, by

sending always to the Railroad Journal one of the first copies of their reports when published. Have the other Massachusetts companies made their annual reports yet? If yea—where are they?

We find in "The Civil Engineer and Architect's Journal," for January 13th last, the following statements, in relation to the use of wrought and cast iron for bridges. The wrought iron bridges are after the plan of "the wooden lattice bridges of America;" the origin of which style, the editor claims for "the late Mr. Smart of Westminster wharf, Lambeth." Possibly this may be the fact—but if so, the Americans have probably made some important improvement upon the original. Will those interested in the subject in this country give up their claim—or will they furnish us their statement for publication? We should like to publish an accurate account of their origin in this country, but must rely upon those who posses the facts to furnish them.

The following papers were read before the Institution of Civil Engineers—January 9th, 1844.

By Capt. W. S. Moorsom, Assoc. Inst. C. E., descriptive of a cast iron bridge over the Avon, near Tewkesbury, on the line of the Birmingham and Gloucester railway. The principal novelty of this work, which was proposed, and its execution superintended by Mr. Ward, of Falmouth, is the mode of constructing the two piers, which were externally of cast iron in the form of caissons, each weighing about 28 tons; the plates composing each caisson were put together on a platform erected upon piles over the site of the pier, the bottom of the river being levelled by a scoop dredger, the caisson was lowered, and some clay being thrown around the exterior, a joint was formed so nearly water tight, that two small pumps drained it in six hours. The foundation being thus excavated to the requisite depth, the caisson, which sank as the excavation proceeded, was filled with concrete and masonry; cap plates were then fixed for supporting eight pillars with an entablature, to which was attached one end of the segmental arches 57 feet span, with a versed sine of 5 feet 2 inches. There were three of these arches, each formed of six ribs of cast iron, and two such piers as have been described, the land abutments being of stone work joining the embankment of the railway. It was stated that this mode of construction was found to be more economical in that peculiar situation than the usual method of fixing timber coffer-dams, and building the piers within them; the total cost of the bridge being only £10,192, and the navigation of the river was not interrupted during the progress of the work. The paper was illustrated by eighteen remarkably well executed drawings by Mr. Butterton.

A paper by Mr. G. W. Hemans, Grad. Inst. C. E., descriptive of a wrought iron lattice bridge erected across the line of the Dublin and Drogheda railway was then read. This bridge, which in construction is similar to the wooden lattice bridges of America,\* only substituting wrought iron for timber, is situated about three miles from Dublin over an excavation of 36 feet in depth; its span is 84 feet in the clear, and the two lattice beams are set parallel to each other, resting at either end on plain stone abutments built in the slope. These beams are 10 feet in depth, and are formed by a series of flat iron bars 2 1-2 inches wide by 3-8 inches thick crossing one another at an angle of 45 degrees; at 5 feet 6 inches above the bottom edge, transverse bearers of angle iron are fixed similar to those now used for supporting the decks of iron steam vessels, and upon those the planking for the roadway is fastened. The account of the mode of construction, and of the raising and fixing the lattice beams, by Messrs. Perry, of Dublin, the contractors, was given in detail, and the author stated that, although it was expected that considerable deflection would occur, which was provided for by forming the beams with a curve of 12 inches in the centre they did not sink at all even when heavy weights passed over them. The total cost of the structure, including the masonry of the abutments was £510. It was stated that this bridge had been erected by Mr. Macneill, M. Inst. C. E., in order to test the soundness of this kind of structure before he applied it in a bridge of 240 feet span to carry the Dublin and Drogheda railway over a canal.

\* The original inventor of the lattice bridge, was the late Mr. Smart, of Westminster bridge wharf, Lambeth, who many years since took out letters patent for the principle.—(Ed. C. E. & A. Journal.)

## CONTENTS:

	Page.
Tables—cubical quantities,	65
Philadelphia and Reading railroad report,	81
Cost of transportation on canals,	88
Report of the Schuylkill navigation—continued,	91
Items,	96